

Instruction Manual

TLDCube



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1 Introduction

1.1 TLDcube

TLDcube is a compact and cost efficient thermoluminescence (TLD) reader to measure, analyze and evaluate thermoluminescence materials using thermal stimulation (TL). It is developed in collaboration with Freiberg Instruments GmbH, Germany.

Innovative design and software enhances easy operation and reliability of the newly developed TLD reader.

1.2 Target Audience

This manual is addressed to the operator of the TLDcube device. The operator should have the essential professional competence to run the measurement device and is obligated to read and completely understand this manual. The manual ought to be placed next to the equipment.

1.3 Intended Application

Thermoluminescence (TL) measurements in applications like,

- Radiation protection
- Medical dosimetry
- Experimental physics
- Environmental research
- Personnel Dosimetry
- Testing irradiation levels in food

1.4 Not Intended Application

All applications which are not listed in section 1.4.

1.5 Technical Specification

Heater	Ceramic contact heater with nitrogen cooling function
Base Plate	Stainless steel, exchangeable
Base Plate types	Chip 3.2 mm x 3.2 mm, Rod 1 mm x 6 mm, Disc Ø 4.5 mm, Multi-Purpose Ø 10 mm
Powder Dish	Ø 8 mm for use with Multi-Purpose Base Plate
Maximum heater temperature	up to 400°C (up to 700°C on special request)
Linear heating ramps	Adjustable up to 20 K/s (20°C to 400°C) – up to 40K/s available on request 10 K/s (400°C to 700°C)
Heating Program	Multi-step program, adjustable temperatures +/- 1K
Regions of Interest	up to 10 ROI, adjustable
Readout time	freely adjustable
Accuracy	±1 % S.D. (for multiple readout)
HV Stability	±0.01 % during 8 h operation
Data output	LAN to PC
Measurement range	6 decades
Signal processing	24 bit, full digital evaluation system
Power supply voltage	100 – 240 V, 50 - 60 Hz
Power consumption	200 VA
Shielding and cooling	Nitrogen gas
Dimension	276 x 148 x 164 mm
Weight	5 kg

1.6 Safety Instructions

In general handle the device with care as mentioned in this user manual. Improper usage may cause personal injury or damage to property. The TLD reader has a ceramic heating element on which the samples are placed for TL measurements. This heating can reach temperatures up to 700°C. Do not touch the heating element before allowing it to cool down to room temperature.

Please observe the warning notices marked in red as “**Warning Notice**” in this user manual.



2 Basic Information and Advices

2.1 Preface

It's necessary to consider the warning notices. The defiance could cause damages to health and property.

It is highly recommended that repair or service of TLDcube is carried out by a trained professional. Please check the local regulations for safe operation of the device.

2.2 Security warning

Don't open the loading tray by force, use the eject button. Loading tray does not open at temperatures above 60°C. Be careful heater may be hot!

2.3 Unpacking the TLDcube

The TLDcube is packed carefully to avoid damages during transport. Do not unpack the device unless requested by us. Damages during transport should be reported immediately.

2.4 Decommissioning

Decommissioning occurs by:

1. Shutting down the computer
2. Switching off the device
3. Disconnecting the device from the main supply

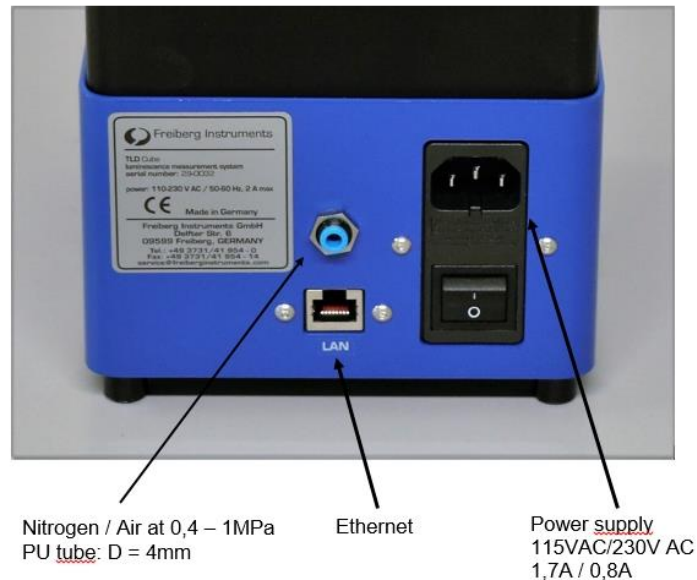
2.5 Storage

Only store the equipment in closed dust-free rooms.

Temperature should not fall below 5 °C or exceed 40 °C; relative humidity must not be higher than 80%.

Warning notice: Disconnect from the power supply when the equipment is not used for a longer period of time.

2.6 Power Supply



2.7 Mechanics

Inappropriate operation can cause property damage and injuries.

External tensions and vibrations should not be applied to the equipment!

For a better cooling of the equipment don't place any other hardware within 20 cm.

2.8 Hazardous Material

An assignment of hazardous materials is not intended.

2.9 High temperatures

The equipment can be warmed up by electrical lost heat. It's not allowed to exceed temperature of 40 °C!

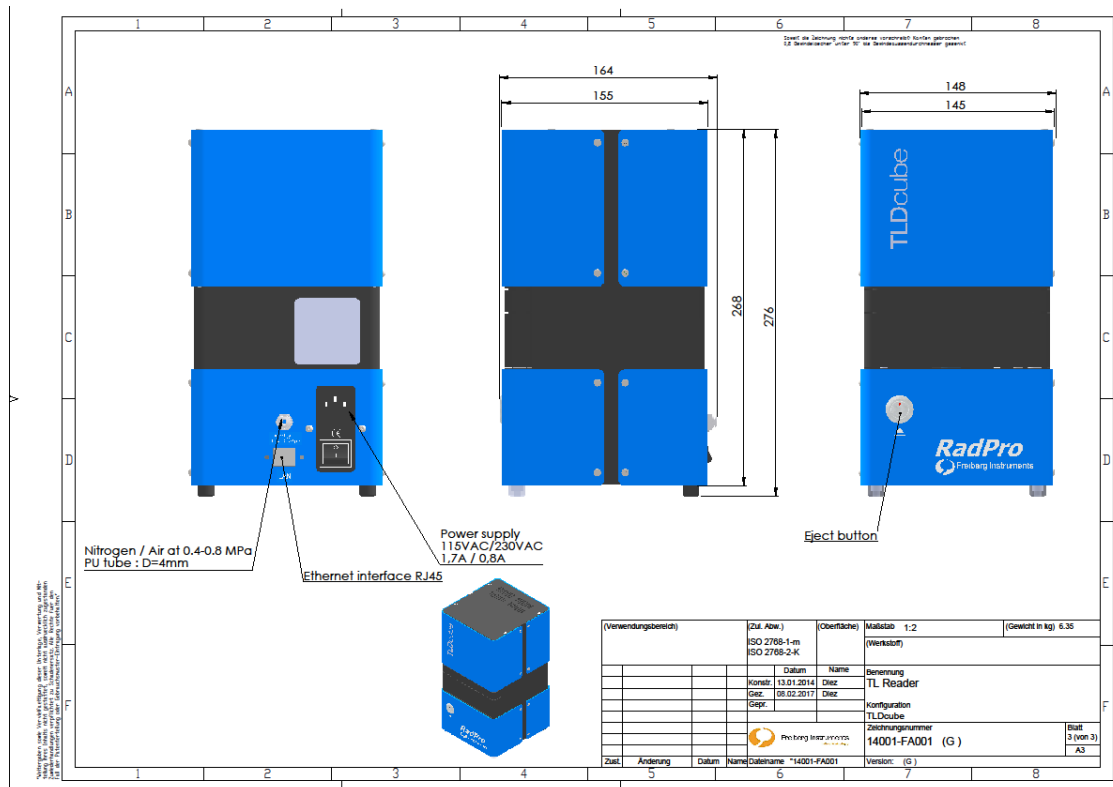
2.10 Spare parts

Spare parts list:

- Nitrogen pump
- PMT tube
- Filters
- Heating Unit
- Fuse

3 General Information

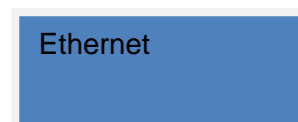
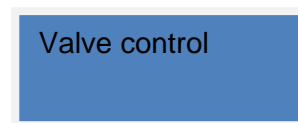
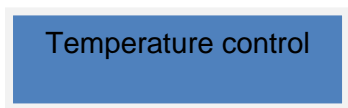
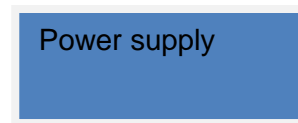
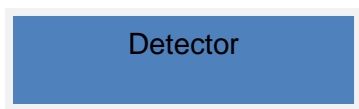
3.1 Basic Construction



Dimensions: 276 x 148 x 164 mm

Weight: Approximately 5.5 kg

3.2 Electronics



3.3 Sample Handling and Loading



Step 1: Check if the PC or Laptop is connected to the device

Step 2: Check if the Nitrogen supply is turned ON, if applicable

Step 3: Turn ON the power supply

Step 4: Push the Eject button in front of the device. (The sample loading tray will open as shown above.)

Step 5: Load the sample as shown in the picture.

Step 6: Manually close the tray. (LED on the Eject button will glow green)

Now the device is ready for measuring the sample.

3.4 Measurement Chamber

The measurement chamber contains a PMT Tube module, Heating Unit, Exchangeable Filter unit and nitrogen gas supply unit.

3.5 Heating Unit

Thermoluminescence (TL), preheat (PH) of materials or elevated temperature measurements need a heating element. Measurements are possible during any part of a heating/cooling cycle, which may simply be a heating ramp but series of several heating steps are possible, too. Software includes further possibilities, e.g. programmable cooling and non-linear heating/cooling functions.

Properties and functions:

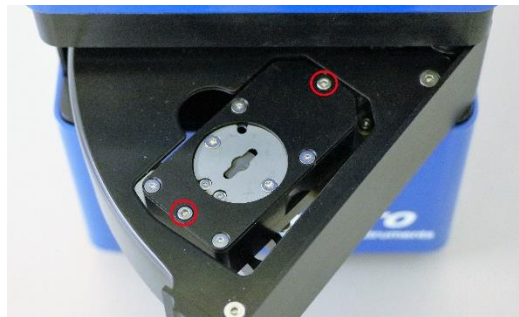
- Temperature range: room temperature (RT) to 400 °C (higher temp. on request)
- heating rate: 0.1 - 20.0 K/s (@ $T_{\max}= 400$ °C; 0.1 - 10.0 K/s (@ $T_{\max}= 400$ °C (higher heating rate up to 700°C available on request)
- highly flexible step-wise programming of heating and cooling cycles within system parameters (i.e. temperature and heating/cooling rates)
- Software options for further temperature control

Warning notice: Do not touch the heating element before allowing it to cool down to room temperature.

3.5.1 Replacing the Heating Unit

The Heating Unit is an independent module of the TLDCube and can be replaced by following the next steps.

1. Open the drawer of the TLDCube
2. Switch off the device and disconnect the power supply
3. Untighten the red marked screws

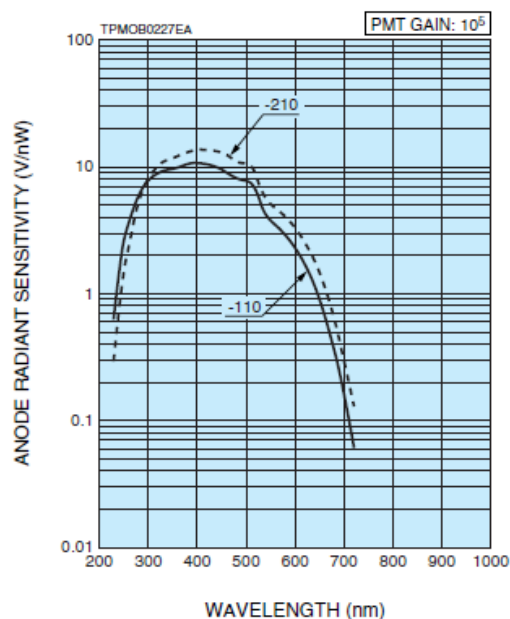


4. Pull up the heating unit and store the removed screws

Warning notice: To Reinstall the heating unit follow these steps backwards and ensure that the device is still switched off.

3.6 Photosensor

- Module H10722-110
- photosensor with integrated amplifier
- for standard applications in luminescence dating and dosimetry
- detection unit with super bi-alkaline cathode PMT (HAMAMATSU)
- sensitivity 230-700 nm
- peak sensitivity 400 nm
- dark counts typ. 10 cps



3.7 Filters

The TLDcube has a flexible filter compartment. It is shipped with a KG3 and BG25 Filter combination for optimal suppression of heater radiation. It is also possible to add a ND filter for strong signals.



Fig: Exchangeable Filter

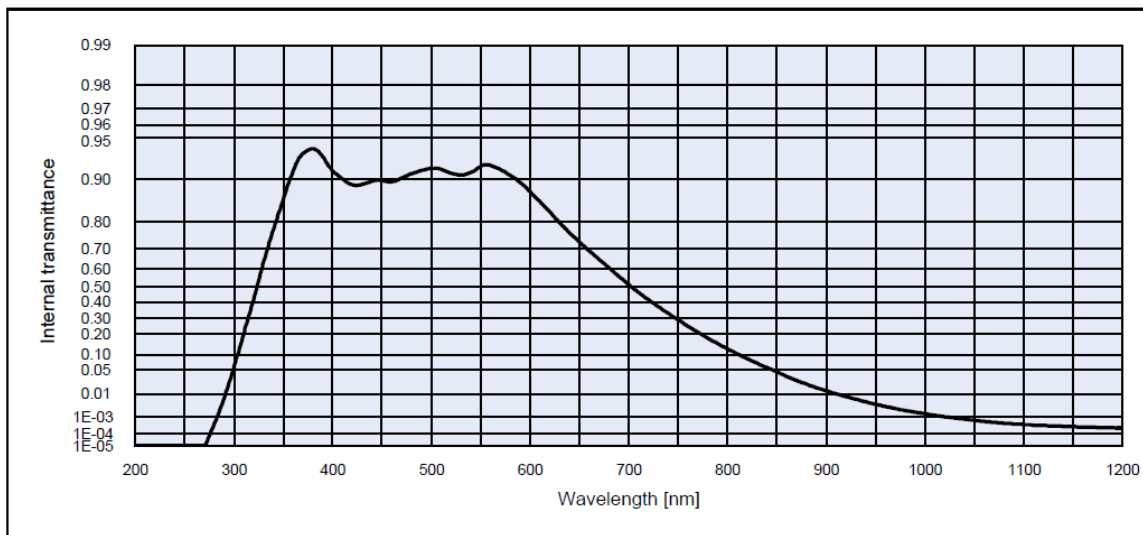


Fig: KG3 Filter Curve

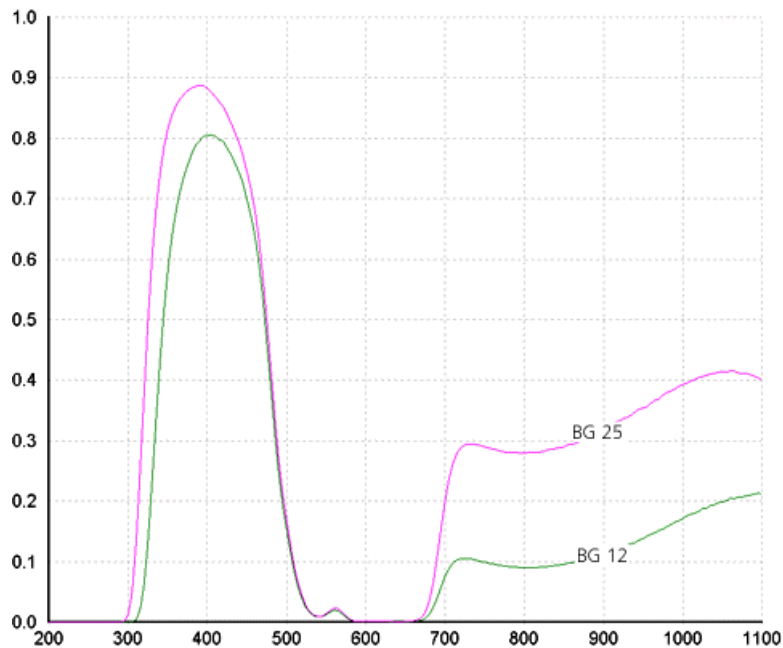


Fig: BG25 Filter Curve

3.8 Reference light

This is an inbuilt unit inside the Measurement chamber of a TLDcube. This checks the functionality of the PMT unit frequently and in case of any defects in or malfunctioning of the PMT unit an error message will be displayed on the TLStudio software. Depending up on the situation the PMT unit must either be serviced or replaced.

4 TLD Materials

Lithium fluoride thermoluminescent phosphor, in the form of powder, solid pellets and chips, is recognized universally as the “golden standard” for applications in radiation protection dosimetry, monitoring of environmental radiation and medical dosimetry.

Depending on the type and shape of the TLD material the base plate or the sample holder is changed by untighten the both torx screws on top of the heating unit.

For detailed information on the available Base Plates or sample holders please read the Appendix towards the end of this document.

Warning notice: Do not change the base plates when the device is connected to the power supply and switched on.

Types and Forms of TLD Materials:

TLD Powders for dosimetry in medical physics:

- Beam dosimetry
- TLD Quality Assurance for postal reference dosimetry
- Typical grain size 80 – 200 μm (customer specified)

TLD Chips, Rods, Discs and Micro Cubes in medical physics:

Diagnostic Radiology:

- Mammography
- Measurement of CT doses
- X-ray screening

Radiotherapy:

- Treatment planning & dose verification
- Stereotactic radiosurgery
- Intensity modulated radiotherapy (IMRT)
- Brachytherapy
- Total body irradiation

Typical detector sizes:

Chips: 3.2 mm x 3.2 mm x 0.9 mm

Rods: \varnothing 1 mm x 6 mm

Discs: \varnothing 4.5 mm x 0.9 mm

Micro cubes: 1 mm x 1 mm x 1 mm

TLD Elements should be handled with vacuum tweezers

5 Installation

Equipment is packed for shipment. Detectors are disassembled. A detail description how to pack and unpack the equipment can be found in a separate report.

1. Position the *TLDcube* device on a horizontal table which is qualified for 15 Kg.
2. Connect the power supply, LAN, nitrogen (if available), as shown in the section 2.6 of this document.

5.1 Prepare for Operation

Make sure the power cord is connected. See construction drawings for a detailed overview where to find certain components or connections.

1. Switch on the master controller using the button in the back of the *TLDcube unit*
2. Start the connected personal computer or laptop
3. Do the software settings as mentioned in section Section 5
4. See the software description about how to start a measurement.

6 Software Basics

TLStudio is a powerful software that works with TLDcube (TLD-reader). The software contains the complete workflow beginning with the creation of heat ramps, measure count curves and up to high level dose evaluation.

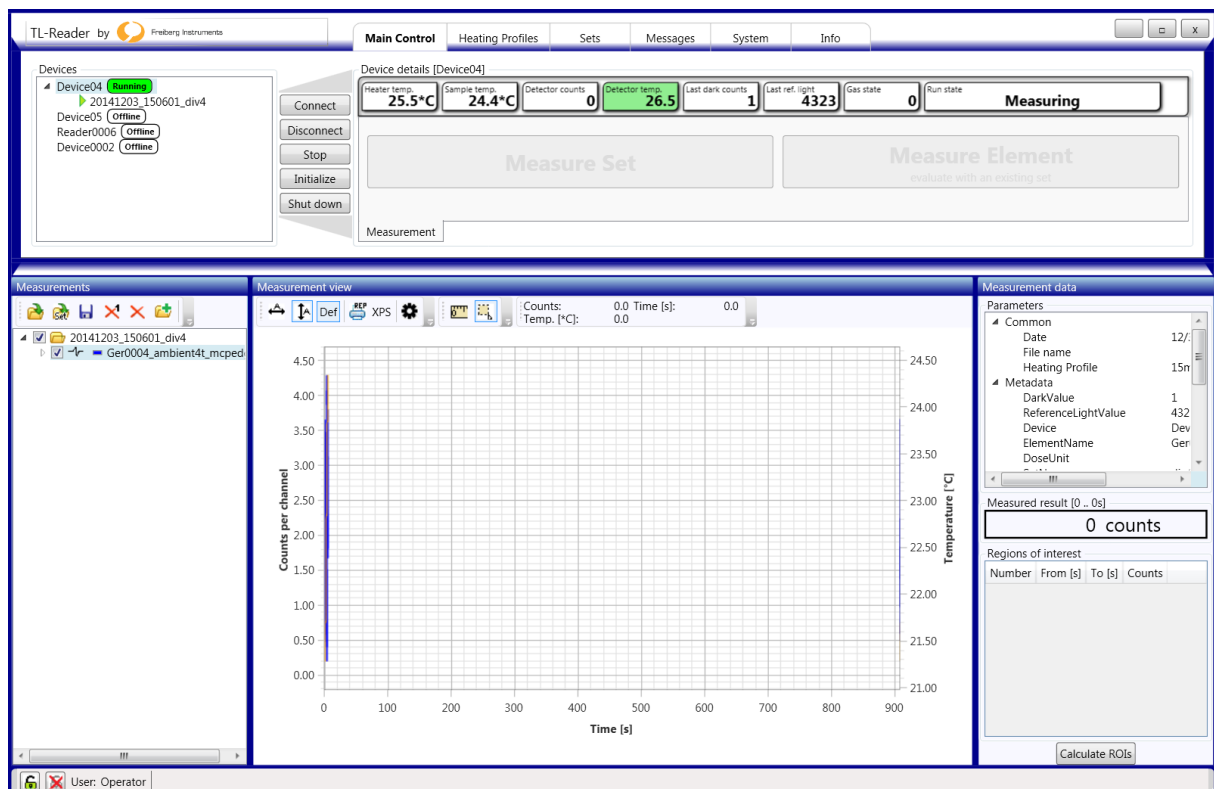
6.1 Program Start up

The program can be started by clicking the desktop icon.



6.1.1 Overview

Once the software has started, the main work screen will be displayed, which is divided in to two main areas: the top “Controlling area” and the bottom “Analyzing area”. The controlling area is used to control the selected device, create heat ramps, and manage sets and so on. The analyzing area will be used for displaying measurement results and comparison of different measurements.



6.2 Initial setup

To initially setup the program the following basic settings are mandatory:

6.2.1 Device connection setup

TLStudio communicates with the device over a TCP/IP network connection. The following settings must be taken in the section “Devices” on tab “Main Control”:

- 1.) Log in with engineer login (user: Engineer, password: engineer)
- 2.) Right click in “Devices” section
- 3.) Click “Add device” in context menu
- 4.) In the “New device”-dialog box type the device name, IP-address and port (standard 10001). Make sure the “Simulation”-check box is **not** selected.

Device settings

Common

Device type (requ. restart): TLCube

Name: TLDcube

Simulation:

Connection

IP address: 172.29.29.10

Port: 10001

Device

Gain: Medium

Sensor temperature: 25

Limits

Valid dark counts (min-max): 0 - 100000000

Valid ref. light counts (min-max): 0 - 100000000

Detection windows

1:

2:

3:

4:

5:

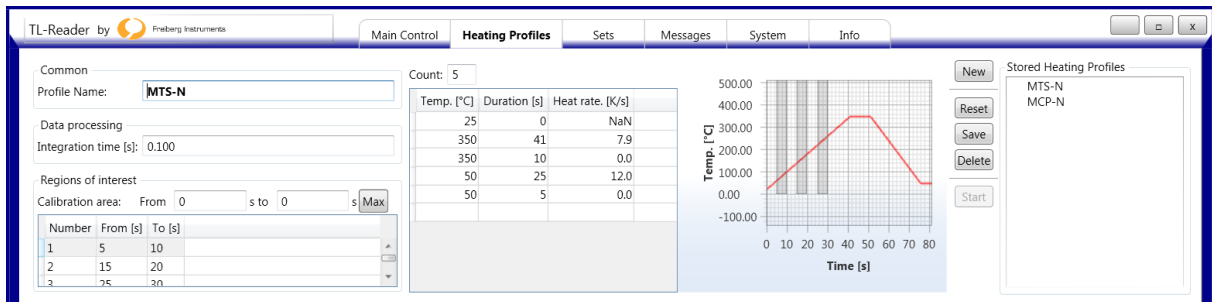
6:

Ok Cancel

- 5.) Click “OK”

6.2.2 Create a heating profile

A heating profile is absolutely required for a user defined measurement. This can be created with the integrated profile editor.



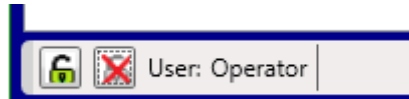
- 1.) Type in a profile name
- 2.) Create a heat ramp in the middle.
- 3.) Click “save” to store the recipe on hard disc.

6.3 Login/Logout

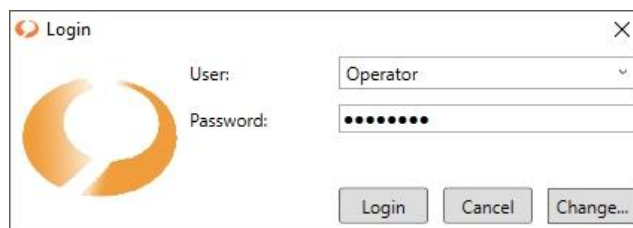
Some TLStudio functions are only accessible via special login.

Possible login roles are operator (this is the standard role) and engineer. The operator login is limited to select recipes/sets and start and analyze measurements. Changes are only reserved to the engineer login.

6.3.1 Login



- 1.) Click the left symbol in the lower left corner -> a dialog will appear
- 2.) Select the desired user role
- 3.) Type in the password
- 4.) Press “login”.



6.3.2 Change password

- 1.) Click the left symbol in the lower left corner -> a dialog will appear
- 2.) Select the desired user role
- 3.) Check the “Change...” button
- 4.) Type in the old password
- 5.) Type in the new password
- 6.) Confirm the new password
- 7.) Click “Login”

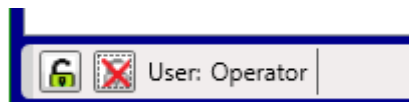


The screenshot shows a 'Login' dialog box with the following fields and buttons:

- User:** A dropdown menu with 'Operator' selected.
- Password:** A text field containing seven black dots.
- New Password:** An empty text field.
- Confirm Password:** An empty text field.
- Buttons:** 'Login', 'Cancel', and 'Change...' (highlighted with a dashed border).

6.3.3 Logout

To logout the current user, press the right symbol with the red cross in the lower left corner.



7 Measurement

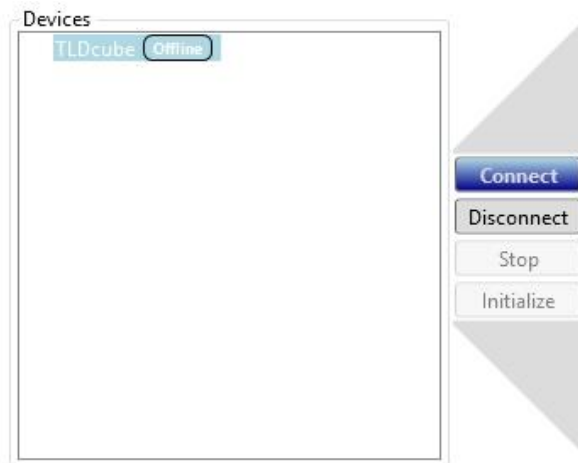
Each measurement is automatically saved into a folder with the selected set name.

7.1 Preliminary software set up

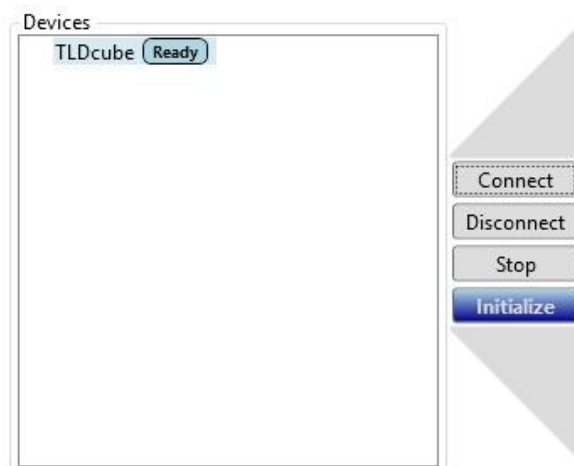
The following steps are required before taking measurements using the software,

(Note: The following steps are not required if you want to just open or analyze older files.)

- 1.) Select device in “Devices” section and click “Connect”.



- 2.) Initialize device and software by clicking “Initialize”



After a successful initialization the device state will change from “offline” to “ready” to take measurements. If an error occurs, reinitialize software and device by clicking “Initialize”.

7.2 Detector temperature

In the device details, the current Photosensor temperature is shown. The background of this field is colored depending on the difference to the setpoint. The reader is shipped with a setpoint of 25 °C, but this point is adjustable. It should not be changed after calibration.

Green means the detector temperature is in a good range. Orange means the value is acceptable, but if the reader doesn't reach green detector temperature within a few minutes, the ambient temperature may be too hot or too cold. Red means the temperature is not in an acceptable range. This means the peltier temperature is broken or the ambient temperature is so extreme, that the peltier has no chance to compensate it.

7.3 Measurement modes

There are different preset and user defined measurement modes. Each mode can be started from the tab "Main Control" after the device is ready to measure.

Device details [Device04]

Heater temp. 25.0°C	Sample temp. 25.0°C	Detector counts 4	Detector temp. 27.3	Last dark counts 1	Last ref. light 4323	Gas state 0	Run state Measuring
------------------------	------------------------	----------------------	------------------------	-----------------------	-------------------------	----------------	-------------------------------

Measure Set Measure Element

7.3.1 Measure Elements with known recipe

This mode is the simplest measuring mode without any dose evaluation (e.g. test heat ramp).

- 1.) Click "Measure Element" -> a popup window will appear
- 2.) Check "Heating Profile" option
- 3.) Select heating profile
- 4.) Type in group and element name
- 5.) Press "Continue" to start measurement

Insert Element...

Device: TLDcube

Mode: Measure set
 Measure element

Set: <None>

Heating Profile: Heating Profile

Group name: TLDcube_Meas

Element name: Meas_EI0001

Continue [ENTER] Abort/Finish [ESC]

The measurement results (data curves) will be displayed in the analysis section of the software.

7.3.2 Measure sets with predefined elements

In this mode a predefined set with elements will be measured. Therefore the Set must be created with the built in Set editor in the controlling area. If the Set is calibrated with several parameters, the resulting dose will be calculated and displayed.

- 1.) Click "Measure Set" -> a popup will appear
- 2.) Select Set
- 3.) Select Element
- 4.) Click "Continue" to start measurement

Insert Element...

Device: TLDcube

Mode: Measure set
 Measure element

Set: Set_01

Heating Profile: Heating Profile

Group name: TLDcube_Meas01

Element: 01

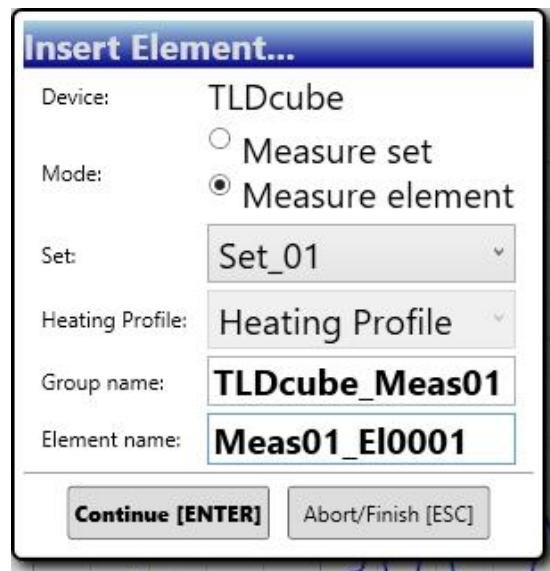
Continue [ENTER] Abort/Finish [ESC]

The measurement results (data curves) will be displayed in the analysis section of the software.

7.3.3 Measure Elements based on existing Set-Calibration

With this mode, it is possible to use an existing Set and calibration to measure and evaluate Elements outside this Set.

- 1.) Click “Measure Element” -> a popup will appear
- 2.) check “Evaluate with...” option
- 3.) Select Set
- 4.) Type in group and element name
- 5.) Click “Continue” to start measurement



The measurement results (data curves) will be displayed in the analysis section of the software.

7.4 Measurement flow

Each individual measurement consists of three steps performed one after another independent from using the “Measure Set” or “Measure Element” measurement mode:

- 1.) Measuring the dark counts.
- 2.) Measuring the reference light counts.
- 3.) Filling the chamber with nitrogen.
- 4.) Measuring the actual luminescence signal.

The currently performed step is announced by the “Run state” element in the “main control” tab.



In addition to this visualization, the state of the device is displayed by a lamp on the “open button” on the device itself. In idle mode the lamp will glow constant whereas a slow pulsing lamp is indicating a running measurement.

The color of the light displays the safety state of the device. A green color indicates that the device is in a safe state. The heater is at a low temperature and the photo counter is deactivated. In contrast a red color indicates that the device is in a working state with the heater at a high temperature and activated photo counter. Force the device open in this state can harm the user and the device and is advised.

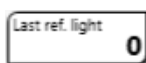
7.4.1 Measuring the dark counts

After loading a sample and starting a measurement, the device will first measure the dark count signal without stimulation. The result of the measurement is visualized in the “Last dark count” element.



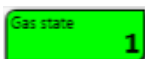
7.4.2 Measuring the reference light counts

In the next step, the device will activate the reference light led which will emit a defined amount of light, measured by the photo counter and visualized in the “Last ref. light” element.



7.4.3 Filling the chamber with nitrogen

In prepare of the actual measurement, the device will now flood the measurement chamber with nitrogen to protect the heater and to create a standardized environment for the measurement. Under certain circumstances, e.g. measuring at low temperatures, the device will continue to measure without nitrogen, if the pressure at the inlet is too low.



The Gas state indicator shows if the pressure at the inlet is sufficient. It is possible that the pressure falls below the threshold during the chamber fill process, but that is not a Problem.

7.4.4 Measuring the actual luminescence signal

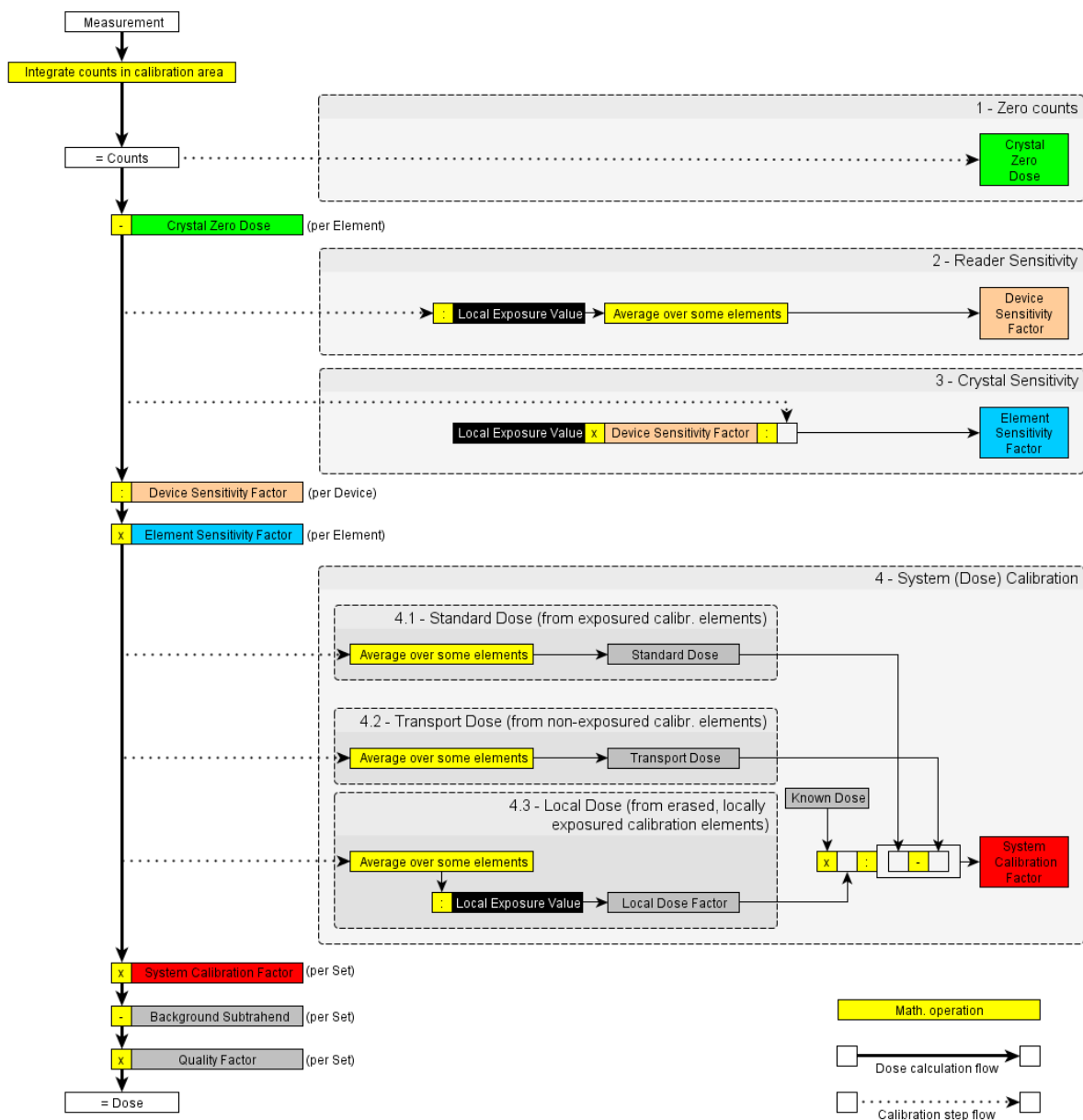
In the actual measurement, the device will execute the assigned heating profile. The current sample temperature and photo counter signal is being shown at the measurement view. Also the actual heater temperature, sample temperature and photo counter signal is visualized in the Device Details Group.

Heater temp. 153.5°C	Sample temp. 118.2°C	Detector counts 11697783
--------------------------------	--------------------------------	------------------------------------

After the measurements, the element “Run state” will change back to “initialized”. When the device is back to a safe state (e.g. after cooling down), the light on the device will change back to green, allowing to unload the sample and prepare a new measurement.

7.4.5 TLStudio Data Flow

TLStudio data flow



7.5 Create and edit heating profiles

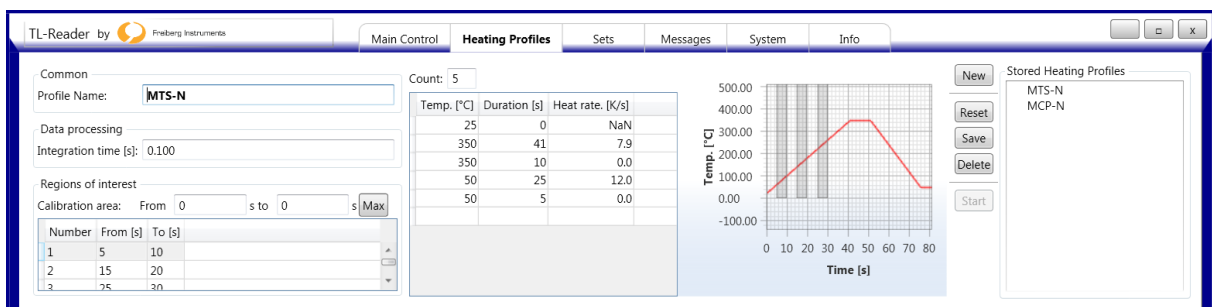
The heating profile editor tab is used to create and edit profiles. An existing profile can be opened by double clicking it in the profile list.

- 1.) [Create new:] Press “New”-button
- 2.) Create or edit heat ramp
- 3.) Set up regions of interest.

The defined regions can be used to count the light emission in this area.

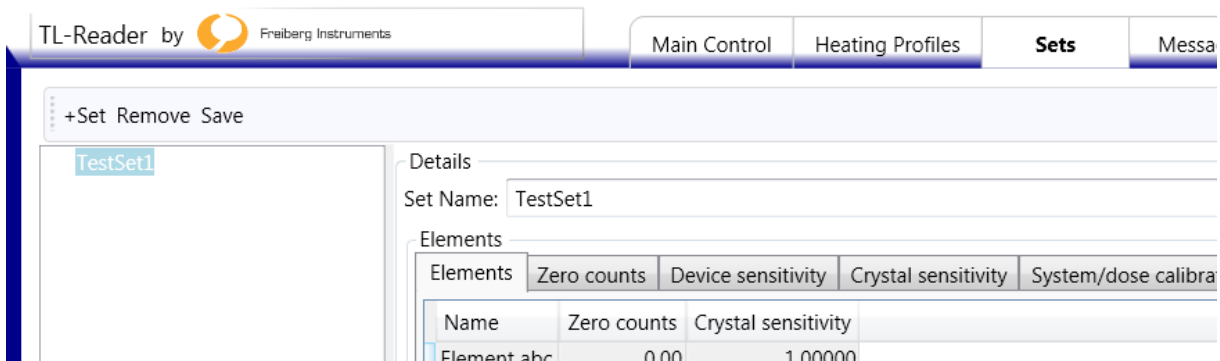
The “Main cal. Area” is the area which is used for dose evaluation. The “Max”-button will adjust the calibration area maximum to the heat ramp duration.

- 4.) [Create new/Copy existing]: Type in an unused profile name
- 5.) Press “Save” to save the profile to hard disk



7.6 Create and edit Sets

A group of elements (dosimeters) is called Set. Those Sets can be created with the built in Set editor in tab “Sets”.



- 1.) [Create new]: Press “+Set” to add a new Set
- 2.) Select the Set to be edited
- 3.) Set/Change Set name

- 4.) Add Elements by typing a name into the “Name”-column. Press “Enter” to accept the new entry.

Elements	Zero counts	Crystal counts	Device sensi
Name	Measured zero counts Avg=NaN	Crystal sensitivity	
001		1.00000	

- 5.) Arrange Sets by pressing “Arrange elements” (first condition: Numbers ascending; second condition: text ascending)
- 6.) Select recipe to measure this Set with

Device sensitivity factor: 1 Local exposure value: 12 Recipe: MTS-N ar Arrange elements

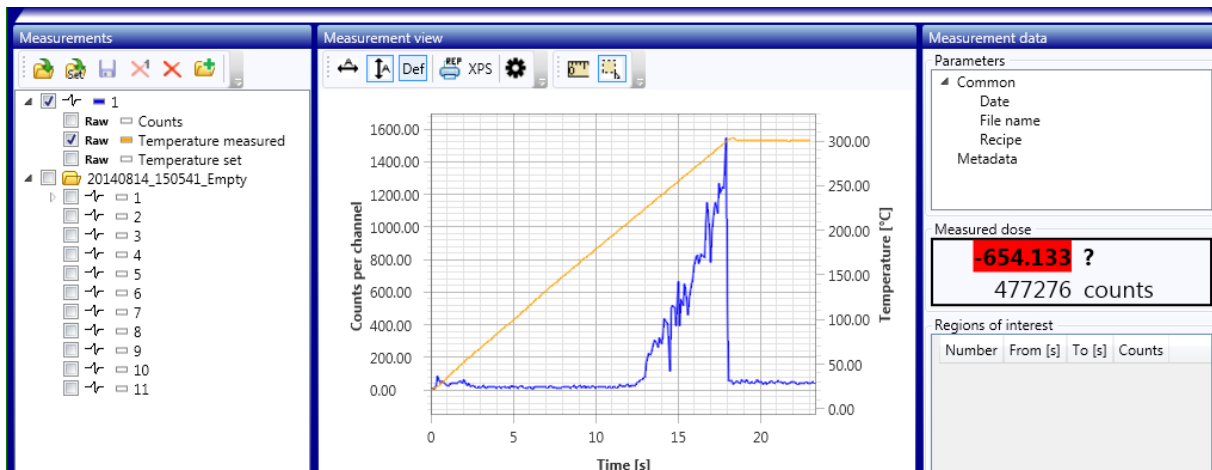
Elements	Zero counts	Crystal counts	Device sensitivity	System calibration
Name	Measured zero counts Avg=1.00			
1	1.00			

- MTS-N
- MCP-N
- Low temp
- MTS-N annealing
- MTS 10K/s
- MTS 8K/s
- MTS 5K/s

- 7.) Click “Save” to save changes.







7.7 Data evaluation

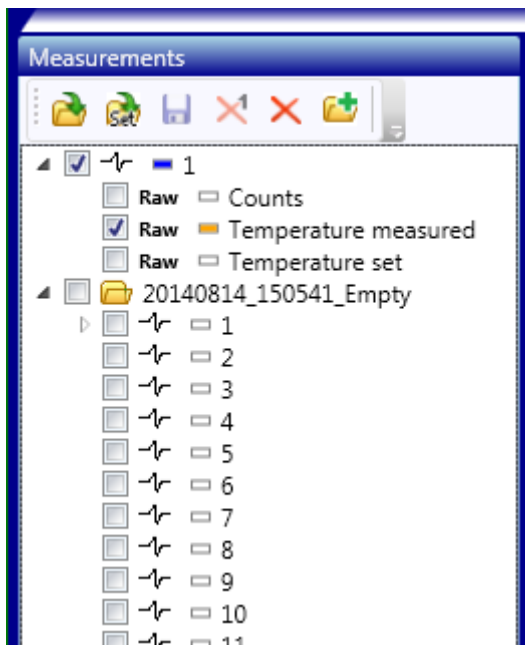
The complete data evaluation is available in the lower analyzing area.



7.7.1 Measurement list

The measurement list provides the ability, to show and compare different measurements. All measurements taken during program runtime will be appended to this list. Older measurements can also be opened.

-  Open single measurement
-  Open Set
-  Save selected measurement/Set as another filename
-  Remove selected measurement/Set from list (not from hard disc)
-  Clear whole list (not from hard disc)
-  Add a Folder to list (e.g. to separate measurements). Right clicking a Folder and select “Load measurement” will load the following measurements into this Folder.

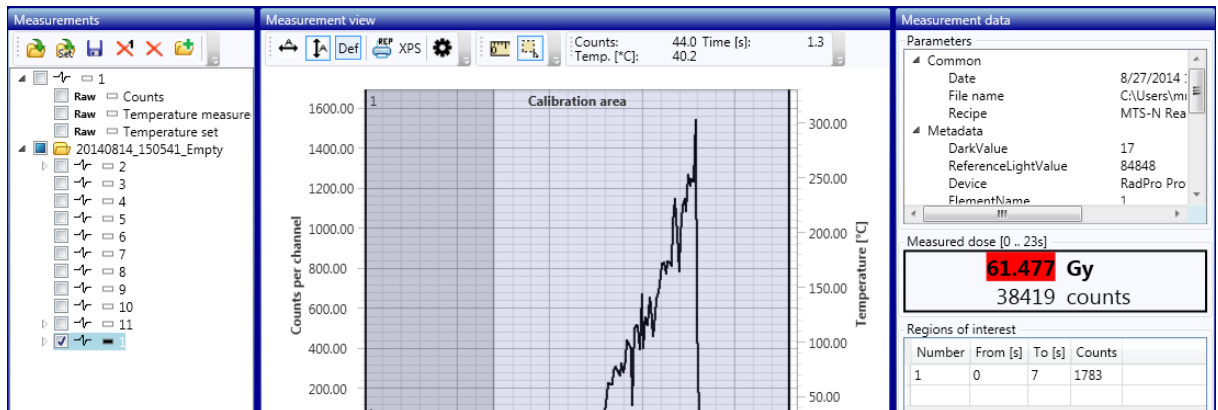


There are two selection modes:

1.) Select by highlighting

This will display the selected object as black curve in the “Measurement view”. Also the related measurement data will be displayed in “Measurement data”.

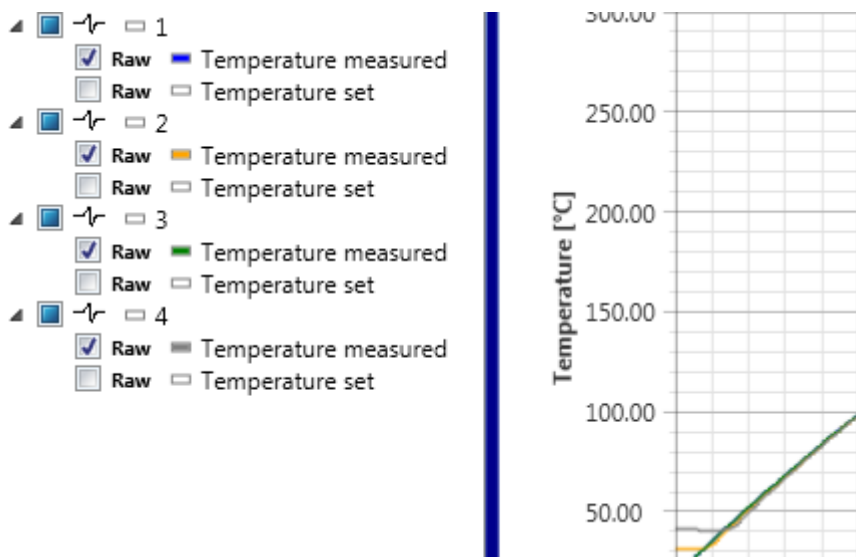
Example: show measurement data



2.) Select by check special curve checkboxes

This will append the selected object to the “Measurement view” – each with another color.









Example: compare heat curves



7.7.2 Measurement view

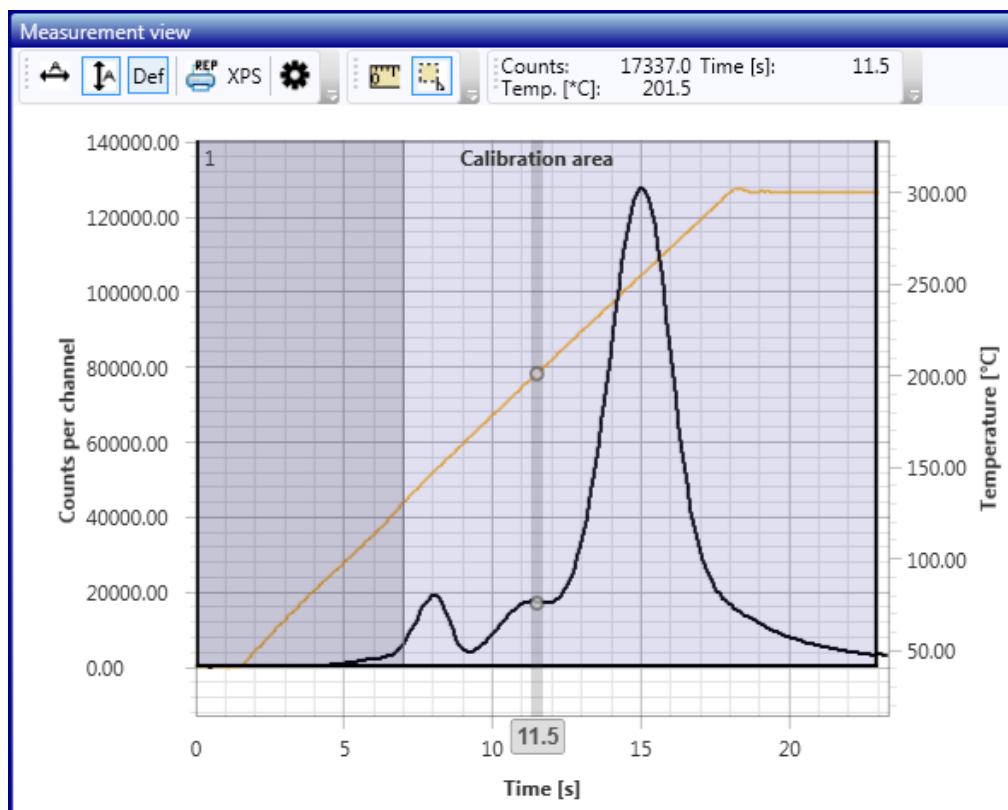
The measurement view shows the selected measurements in the measurement list.

Zooming can be performed by creating a mouse rectangle around the desired area. A mouse double click will reset zoom to default/auto.

-  Performs horizontal automatic zoom
-  Performs vertical automatic zoom
-  Resets scaling/zoom to default scaling
-  Prints report to a selectable printer
-  Prints report to XPS format
-  Setup optional default scaling for different axis types (e.g. temperature) for better comparison between measurements
-  Enables mouse measuring mode:
 - 1.) Select start point per mouse click
 - 2.) Select end point per mouse click
 - 3.) The resulting X and Y distance will be displayed
-  Enables mouse rectangle zoom mode

Counts: 17337.0 Time [s]: 11.5
Temp. [°C]: 201.5

Displays actual information on hovered mouse point (related to a selected measurement by highlighting).



7.7.3 Measurement data

All measurement parameters are displayed in the “Measurement data” section.

Measurement data

Parameters

- Common
 - Date: 11/10/2014 8
 - File name: O:\1 Apparatur\reforig
 - Heating Profile: reorig
- Metadata
 - DarkValue: 3
 - ReferenceLightValue: 548
 - Device: Device05
 - ElementName: Ger05_ref5_re
 - DoseUnit:

Measured result [11 .. 25s]

1300063 counts

Regions of interest

Number	From [s]	To [s]	Counts

Calculate ROIs

The regions of interest can be modified by editing the list in the lower area. With “Calculate ROIs” the counting will be performed for the new or changed regions.

Example: Divide Region 1 into 2 and 3:

Regions of interest			
Number	From [s]	To [s]	Counts
1	0	7	51826
2	0	4	2662
3	4	7	49164

Calculate ROIs

8 Messaging system

Errors, warnings and related information will be logged into the tab "Messages".

Timestamp	Device	Category	Type	Text	Data
2/8/2017 2:04:29 PM		Application	Information	Application started	

9 Settings

9.1.1 Device settings

From the context menu under the “Devices” section in “Main Control”, select “Settings...”.

This menu is only available with engineer login.

In the dialog box the device specific settings can be taken:

- 1.) “Simulation” will use this device as a “like reality device” with random generated data.
- 2.) “Connection” contains information about the network connection of this device.
- 3.) “Limits” provides the possibility, to set a warn point for dark or reference light counts.
- 4.) Adjust Sensor Temperature regarding your needs. It should be about room temperature. The Sensor is heated / cooled to that temperature to ensure temperature stability. If you set this temperature too far away from room temperature, the device is perhaps not able to get the sensor to that temperature. Keep in mind that the device is more capable of heating than of cooling.
- 5.) If desired, adjust photo sensor Gain. Available is medium, low and high gain with a factor of about 10 in between. The gain also has effect on dark counts and reference light. Since that gain is transmitted as a control voltage with logarithmic scale, the accuracy is NOT very high (although reproducibility IS high). Do not compare measurements done with different photo sensor gain settings. This setting is only useful to measure samples that could not be measured with the standard range.

Clicking “Ok” will save the changes. Clicking cancel will discard changes.

9.1.2 Program settings

The program-wide settings are available under the tab “Settings”.

Settings

Data processing
Data backup path: backupdata ...

Warn limits
 Count warn limit: 5000000

View
Show measurement list:
Show measurement view:
Show measurement data:

CSV export
Automatic path: ...
Column separator: ;
Decimal mark: ,
Point channel time [s]: 0.1

Measurement
Enable multiple measurements:
Language: English

Timestamp:
Measurement name:
Set name:
Element name:
Dark value:
Ref. light value:
Detection window:
Heating profile name:
Regions of interest:
Measured dose:
Measured counts:
Count curve (measured):
Heat curve (measured):
Heat curve (set):

Save Cancel

“Data backup path” is the standard backup path to store measurements after finishing.

“Count warn limit” will warn, if the calculated counts are above the limit.

“View” will show or hide the views in the analyzing area.

“CSV export” contains some settings to define the csv-Export by user. If “Automatic path” is set, each measurement will be appended to a horizontal aligned csv-file into this folder.

Pressing “Save” will save the changes. Cancel will be discarding them.

10 Software information

For service requests or software version the tab “Info” will provide the necessary information.



11 Appendix

