Mystrica 2.0 ™

wireless colorimeter

User Manual

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Applications

The colorimeter is suitable for educational use. It is not intended for clinical, commercial or research applications.

It can be used

- as a stand-alone instrument

- with tablet computers and phones using the iOS or Android apps available free from the Apple app store or Google Play Store.
  Requires Bluetooth 4.0.

- with PCs running Windows using the free software download.

The uses are primarily in secondary and tertiary science education, particularly for Biology and Chemistry.

Detailed suggestions for practical activities can be found at www.mystrica.com and include:

- rates of chemical reactions, determination of rate order

- investigations with enzymes – effects of temperature, pH, inhibitors, enzyme kinetics

- quantitative determination of biological molecules – sugars, protein, vitamins, etc.

- quantitative determination of inorganic ions – nitrate, phosphate, etc

- population growth of micro-organisms

- and others

Package Contents

- ☐ Mystrica Colorimeter
- ☐ Cuvette Stand
- ☐ 10 Cuvettes
- ☐ 10 Cuvette Caps
- ☐ 2×12mm Test-tubes
- ☐ USB Cable (A to mini B)
- ☐ Device Name Label
- ☐ Password
- ☐ Laminated Instructions
- ☐ User Manual

Routine Maintenance

- After use check that the cuvette holder is empty and that nothing has been spilled inside it.
- In the event of a spill mop it up with a cotton bud or a rolled-up piece of absorbent paper.
- Wipe the outside with a damp cloth to remove spills and stains.

Device Name

Each colorimeter has a unique name that is used to identify it to the app when the wireless function is in use. This is initially set to correspond to the serial number on the rear label but can be changed by anyone in possession of the Password (see page 19).

light path ⟶
AVOID SPILLS
USE CUVETTE CAPS
myst01

Write the device name here and attach the label to the front of the colorimeter

The security level for the Device Name is not high. The purpose is to allow each colorimeter to have an easily recognised name while trying to avoid unauthorised alterations by restricting knowledge of the Password.

Safety

The Mystrica colorimeter is a robust instrument but can be damaged by severe spills if these penetrate to the electronics. Avoid these by using cuvette caps. Minor spills will be trapped in the well at the bottom of the cuvette holder and can easily be removed with a cotton bud or rolled-up piece of absorbent paper.

AVOID SPILLS – <u>USE CUVETTE CAPS</u>

Wipe the outside of the cuvette before putting it in the colorimeter.

DO NOT PUT ORGANIC SOLVENTS SUCH AS PROPANONE OR ETHANOL IN PLASTIC CUVETTES. USE TEST-TUBES OR GLASS CUVETTES FOR THESE.

The readings on the colorimeter can be affected by changes in temperature. Avoid placing the unit in direct sunlight or working in an environment subject to large changes in temperature. If you are using the colorimeter in such an environment you should recalibrate frequently.

Controls

⏻ Pressing the power switch turns the unit on or off.
In stand-alone mode the unit switches off after 2 minutes to conserve battery power.
When the wireless or USB connections are in use the unit stays on unless switched off by pressing the power switch.

- CAL calibrates the unit to 0.000 Absorbance or 100.0% Transmittance.
- RGB switches between the red, green and blue light sources.
- A/T switches display between Absorbance and Transmittance.

Display
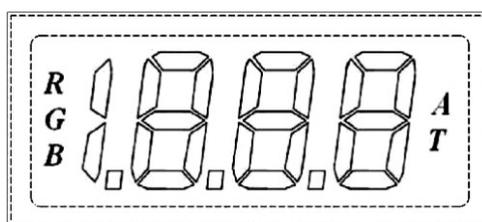
- Indicates which colour of light has been selected, **R**ed, **G**reen or **B**lue.
- Indicates whether the unit is displaying values as **A**bsorbance or **T**ransmittance.
- Displays values of transmittance between 0.0% and 100.0% and absorbance values between .000 and 1.999. The software for PC, tablet or phone can show higher values and negative values.

Non-numeric readings

The display cannot show negative values or values greater than 1.999 (Absorbance) or 199.9 (Transmittance).
The following non-numeric displays may be encountered.

- $\sqcap\mathcal{P}\mathcal{G}$ - the absorbance is negative, i.e. less than the absorbance of the solution used for calibration. **Recalibrate** using the least absorbent solution (usually water).

- $H\iota$ – the absorbance is higher than 1.999 – a reading may still be available with the computer software.

- $H\iota$ – transmittance is higher than 199% **Recalibrate**.

- $b\overline{H}t$ – the batteries are low and should be replaced. This should be a very rare occurrence.

Power Supply

The unit uses 6V from four AA batteries.
These are inserted by removing the screw on the battery holder.
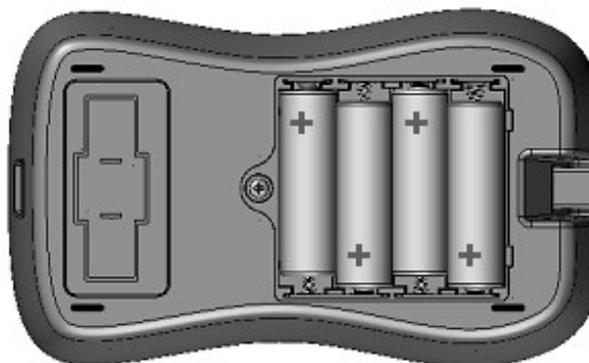
When the batteries need to be replaced the display will show $b\overline{H}t$ on startup.

Battery life for 1000mAh AA batteries is estimated at 100 hours of continuous use. Battery replacement should be a very rare event.

When connected through the USB link to a computer or a USB mains socket the unit draws its power through the link and is permanently on.

Cuvettes

The samples to be measured are placed in standard 4.5ml glass or plastic cuvettes. The length of the light path is 10mm.

Satisfactory results can be obtained with volumes down to 1ml. For lower volumes semi-micro cuvettes can be used but the unit is not intended for semi-micro or micro applications.

Some cuvettes have four clear faces. Many have two clear faces and two frosted or ribbed faces. The clear faces must be aligned with the light path, (i.e. across the unit parallel to the display).

The unit is supplied with ten plastic cuvettes with lids and one cuvette stand. Additional cuvettes, lids and cuvette stands are available through www.mystrica.com

Test-tubes

12mm test-tubes fit the cuvette holder and will give good results, though cuvettes are probably more accurate. Note that older versions of the colorimeter (pre-wireless version 2.0) are unsuitable for use with test-tubes because the cap must be in place to prevent external light entering. The new colorimeters have a brighter light source and are less prone to interference from external light although this should be guarded against in very bright conditions.

2 × 12mm test-tubes are supplied with the colorimeter.

Use glass test-tubes or glass cuvettes for organic solvents (see 'Safety' page 4)

How the colorimeter works

The light source is one of three light emitting diodes, (LEDs), which provide Red (~630nm), Green (~525nm) or Blue (~465nm) light.

The light passes through the sample in the cuvette and is detected by a photodiode.

Transmittance is a measure of the intensity of light passing through the sample, or an indication of the amount of light energy passing through. There is a simple linear relationship between transmittance and intensity which can be expressed as:

$$T = \frac{I}{I_o}$$

where I_o is the intensity of the light entering the sample and I is the intensity of light coming out of the sample. This value is usually given as percent.

Absorbance is defined as $\log_{10}\left(\frac{I_o}{I}\right)$, or $2 - \log_{10}T\%$

There is a linear relationship, (Beer's Law or the Beer-Lambert Law), between absorbance and the concentration of the light-absorbing substance in the sample. In fact absorbance is determined by concentration and by the length of the light path through the sample. For most experiments in biology and chemistry the linear relationship with concentration makes absorbance the measurement of choice.

How to use the colorimeter

Calibration

This sets the value of a predetermined solution, (the blank), to 100% transmittance, or an absorbance of 0.
The blank would usually be pure water though this is not necessarily the case.

Press the **power** switch ⏻ and select the desired colour of light by pressing **RGB**.

Select absorbance or transmittance by pressing **A/T**.

Insert a cuvette containing the blank in the colorimeter.

Make sure the clear faces are aligned with the light path.

Press **CAL.** The display will show CAL for a few seconds, then either $.000$ (A), or 100.0 (T).

Taking readings

Replace the blank with a cuvette containing the liquid to be measured, **close the cap** and **read the value** from the display.

In stand-alone mode the colorimeter will switch off automatically after 2 minutes to conserve battery power. **The settings are retained** so to take a reading simply press the power switch and continue working.

After use

Switch off by disconnecting from the app or USB or by pressing the power switch.
Check inside the cuvette holder and **wipe up any spills** with a rolled up piece of absorbent paper.

Wireless connection

Requirements

The colorimeter can connect wirelessly to any device incorporating Bluetooth 4.0. This includes:
- iPads (Air, Mini, 3rd & 4th generation) and iPhones (4S and later – not 4)
- Android devices (Nexus 4,5,7 and 10 and others)
- Many PCs since 2014. Those without Bluetooth 4.0 incorporated may be connectable using a dongle.

For a full list of Bluetooth 4.0 tablets, phones and laptops see http://www.bluetooth.com/Pages/Bluetooth-Smart-Devices-List.aspx

iOS app

Colorimeter

The app 'Mystrica Colorimeter' is free from the Apple App Store.
When the app is opened the Setup screen appears.

'Setup' screen (see facing page)

The name of every device switched on within range will be shown and one can be selected.
You can use the 'Set Name' tag to rename the device (see p 21)

Before connecting select the 'Logging Interval'. This will be the time between recorded readings when the colorimeter is collecting continuous data (1, 5, 30 seconds, 2 or 30 minutes).

Tap 'Connect'. The colorimeter must be switched on. When a connection has been successfully established the 'Connect' tab will change to 'Disconnect'.

Tap 'Disconnect' to switch off the colorimeter – or press the power switch.

Select '**Setup**', '**Table**' or '**Graph**' from the bottom of the screen.
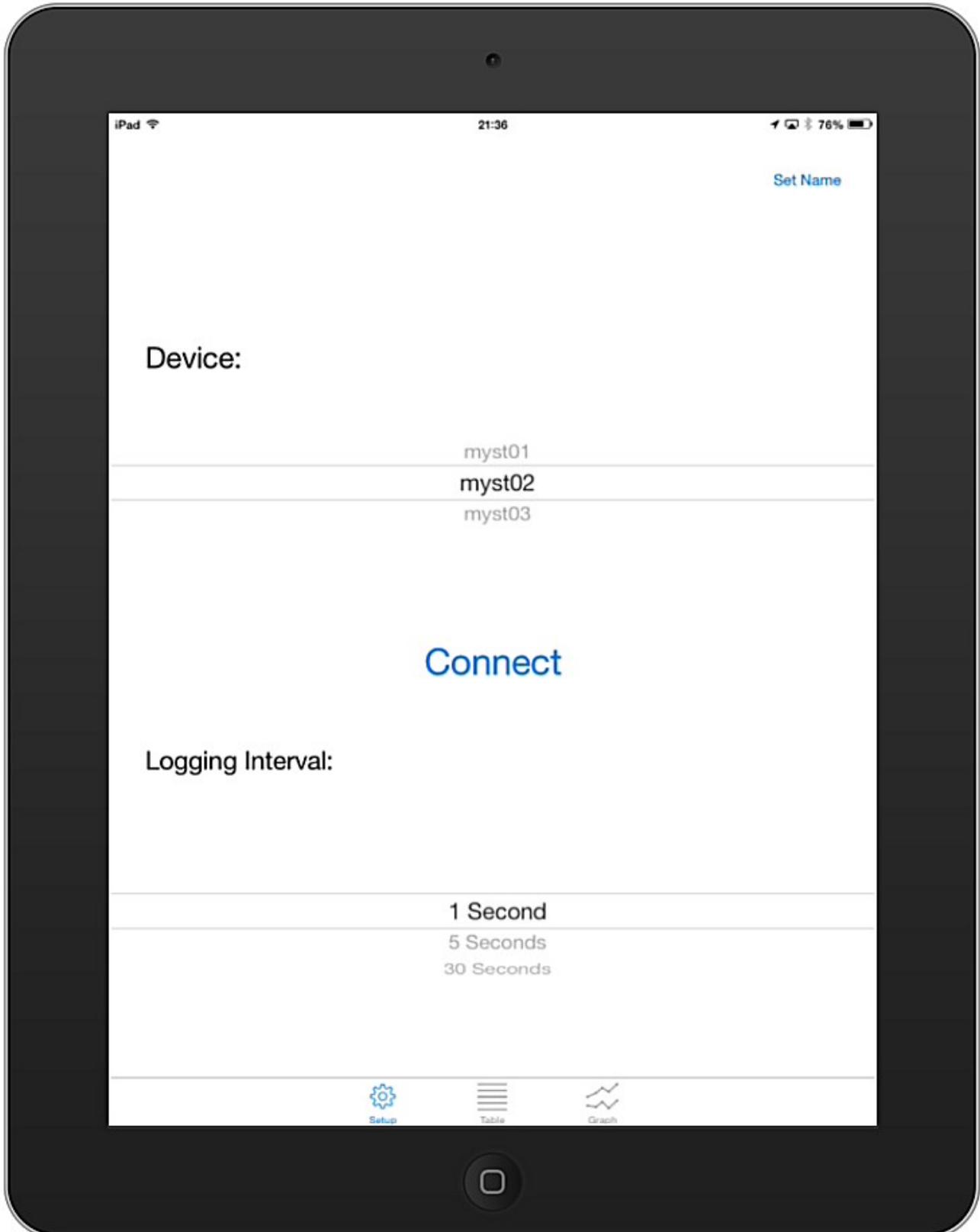
The 'Table ' screen (see facing page)

The transfer of information between app and colorimeter is two-way. Tapping the screen changes the colorimeter settings. Changing the settings on the colorimeter changes the screen display.

1   Shows the current reading on the colorimeter.

2   Tap to calibrate.

3   Tap to select **R**ed, **G**reen or **B**lue light.

4   Tap to select **A**bsorbance or **T**ransmittance.

5   Tap to start and stop continuous data collection.

6   Tap to clear all data and reset the time to zero.

7   Tap to collect only the current reading (see page 21).

8   Tap to type in notes (see page 21).

| | | 16:12 | | 📺 ✳ 100% ▭ ⚡ |

36.1%

Calibrate

| R | G | B | | T | A | Clear | Start Logging | | Separate Event |

Note:

Enter X Value for this Datum

Time	Transmittance	Absorbance	Colour	Note
0 s	75.5%	0.122	R	
1 s	77.2%	0.113	R	
2 s	78.8%	0.104	R	
3 s	80.5%	0.094	R	
4 s	82.5%	0.084	R	
5 s	84.4%	0.074	R	

Setup   Table   Graph

The 'Graph' screen (see facing page)

The axes scales change automatically to accommodate the data as they are collected.

1 y-axis is either Transmittance or Absorbance.

2 x-axis default is time in seconds but it can be changed to record any numerical values, eg concentration, by entering numerical values using the 'Note' tag (see page 21).

3

Best Fit Line

Tapping any point on the graph highlights it. Once two or more points have been selected the app calculates the best fitting straight line through the points, draws the line and displays the values in the form
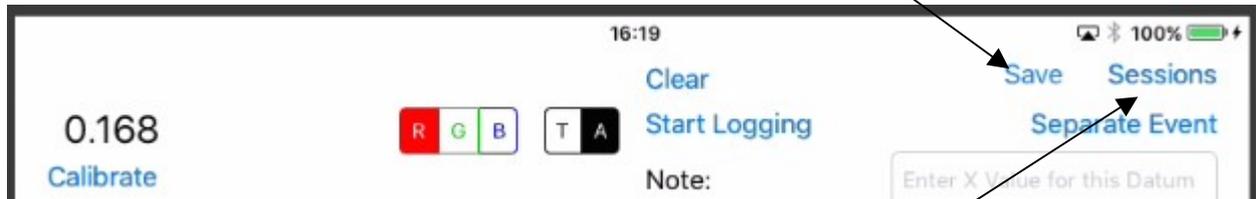
$$y = ax + b$$

where **a** is the gradient of the line, ie change in Absorbance or Transmittance per second or whatever units are on the x-axis (see page 21) and **b** is the intercept on the y-axis.
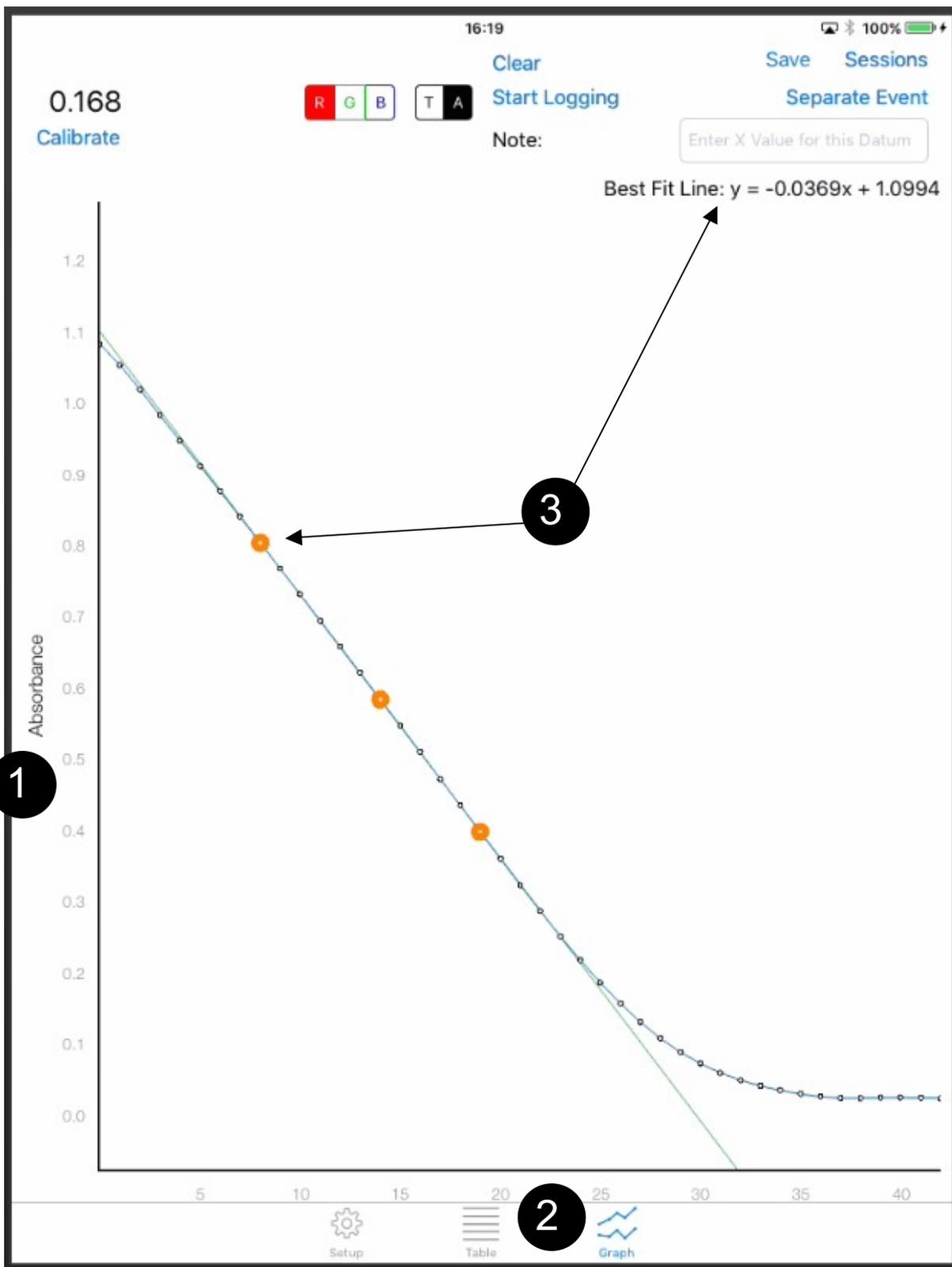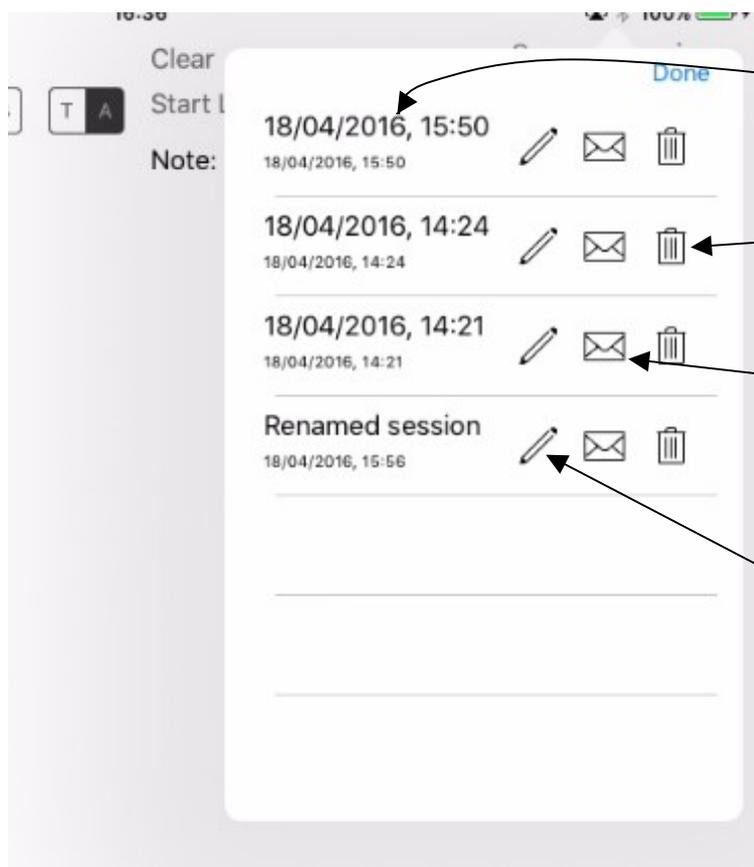
Saving results

To save and recall results switch to the Graph screen.

Tap 'Save' to save the current session.

Tapping 'Sessions' recalls all saved
sessions as shown below.

Tap here to recover
this session.

Tap here to delete
this session.

Tap here to email this
session as a .csv of the
data and a .png of the
graph.

Tap here to rename
this session

Android app

Colorimeter

The app 'Mystrica Colorimeter' is free from the Google Play Store

When the app is opened the screen shown on the next page appears (landscape view for tablets).

Android phones display the screen in portrait orientation with the layout slightly different and the table and graph displays on separate pages but the differences are minimal.

The transfer of information between app and colorimeter is two-way. Tapping the screen changes the colorimeter settings. Changing the settings on the colorimeter changes the screen display.

To connect a colorimeter tap <u>here</u>
- all devices switched on within range
will be displayed and you can select one.
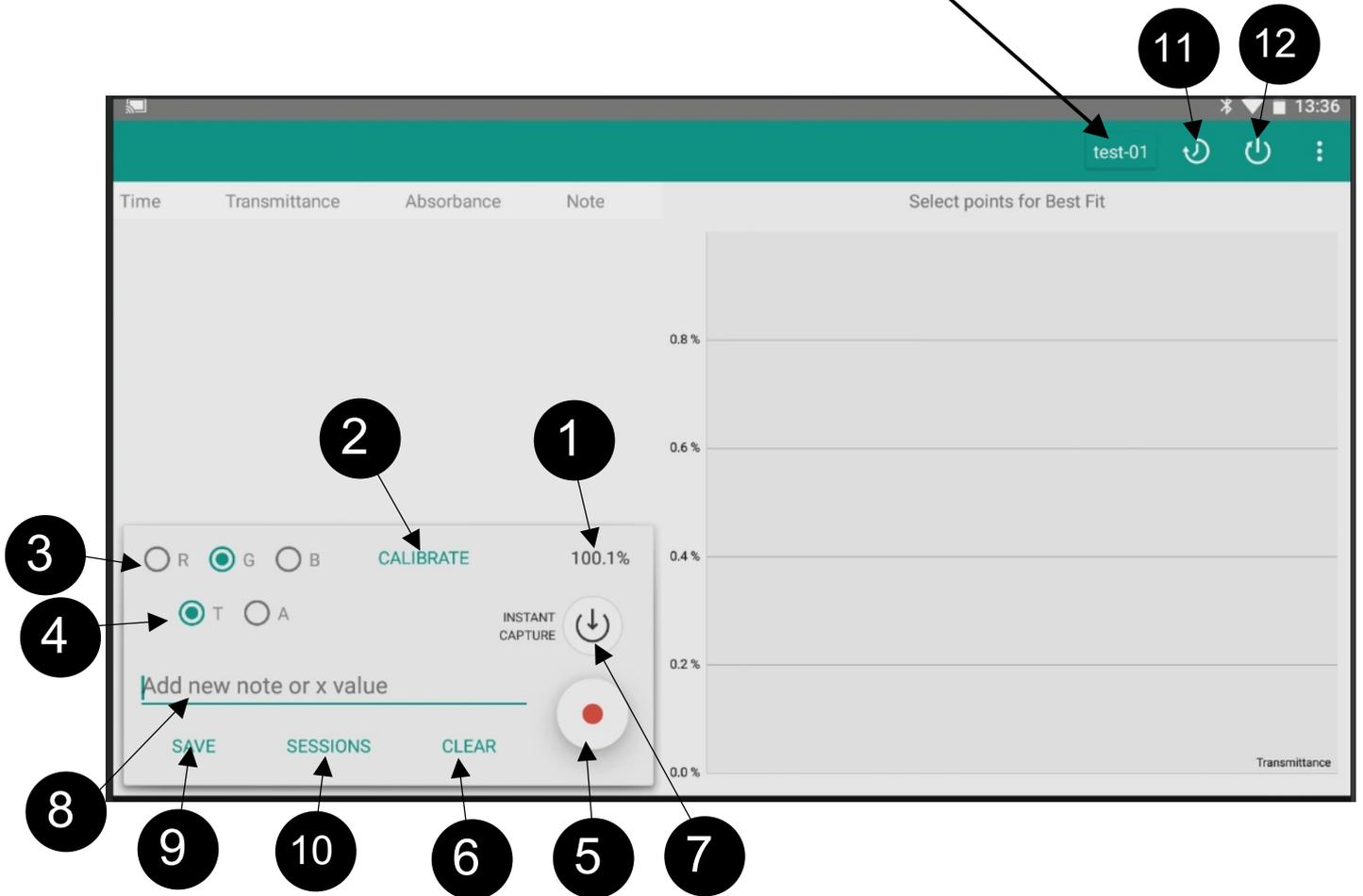
1 Shows the current reading on the colorimeter.

2 Tap to calibrate.

3 Tap to select **R**ed, **G**reen or **B**lue light.

4 Tap to select **A**bsorbance or **T**ransmittance.

5 Tap to start and stop continuous data collection.

6 Tap to clear all data and reset the time to zero.

7 Tap to collect only the current reading (see page 21).

8 Tap to type in notes (see page 21).

9 Tap to save results.

10 Tap to recover saved results.

11 Tap to select the sampling rate.

12 Tap to select the duration of capture (not available on iOS app).

Best Fit Line

Tapping any point on a graph highlights it. You can also select points by tapping the relevant point in the table. If two or more points are selected the app calculates the line of best fit – see page 14

Saving results

Tapping the 'Save' button saves the current data. Tapping 'Sessions' recovers all the saved data - the screen shown below appears and the required session can be selected, deleted, renamed or emailed. Emailing sends the results as a .csv data file and the graph as a .png image file.
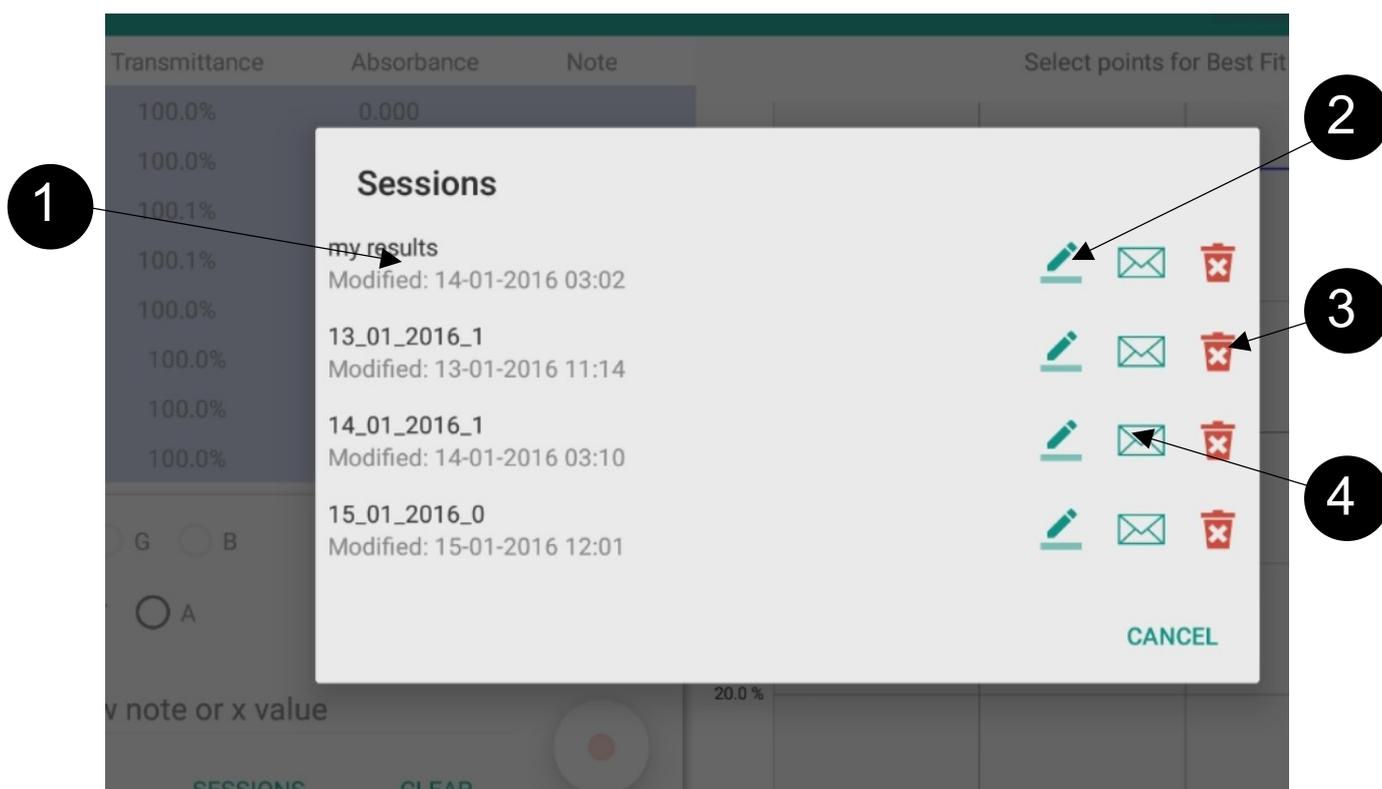
1   Tap here to recover this session.

2   Tap here to rename this session.

3   Tap here to delete this session.

4   Tap here to email this session.

Renaming the colorimeter

Each colorimeter is supplied with a unique identity, the Device Name. This can be changed by anyone in possession of the password supplied with each unit. Names must be between 4 and 10 characters.

iOS: Use the 'Set Name' tag on the Setup screen.

Android: Tap the icon on the connection screen (only appears once the device is connected) and enter the new name and password.

Separate events

When the 'Separate Event' tag is tapped only the current reading is recorded in the results table.

The 'Note' tag

Anything entered in this box will appear in the 'Note' column of the results table. It can be used to record details of the experiment, to identify the person collecting the results, to record reaction conditions, etc.

If a number is entered in the 'Note' box this will be shown on the graph x-axis. This allows a graph to be constructed of absorbance against concentration or anything else that has a numeric value. (This works if only numbers are entered, otherwise the x-axis is shown as the default setting – time in seconds).

There are a number of short video clips and interactive image maps illustrating the operation of the apps on the website www.mystrica.com

Connection to a PC
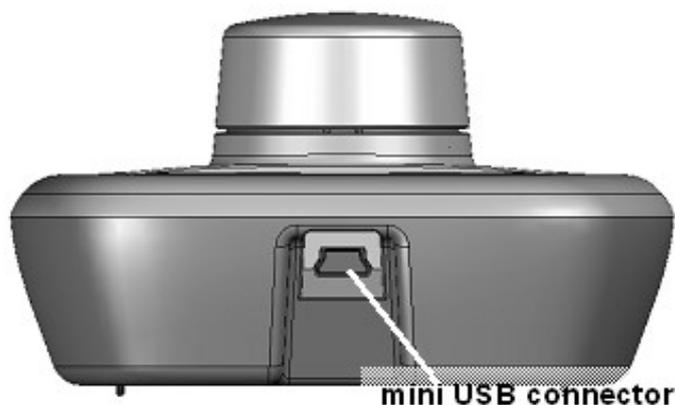
mini USB connector

The colorimeter connects to a computer through the mini USB connector shown. PCs incorporating Bluetooth 4.0 or able to use a Bluetooth 4.0 dongle can connect wirelessly. The power switch turns the unit on or off.

PC Software

The software is FREE to DOWNLOAD
see www.mystrica.com/Software/Download

Using the colorimeter connected to a computer by the USB link you can:

- set up project and experiment files to collect and store results

- display and store data as tables and graphs

- collect data as a continuous stream or as separate events

- carry out simple data manipulations such as calculating rates of reaction and lines of best fit

- copy data into more sophisticated data analysis applications such as Excel or Autograph.

System requirements

Windows 2000, XP, Vista, Windows 7,8 or 10 with the .NET Framework 2.0 or later installed.
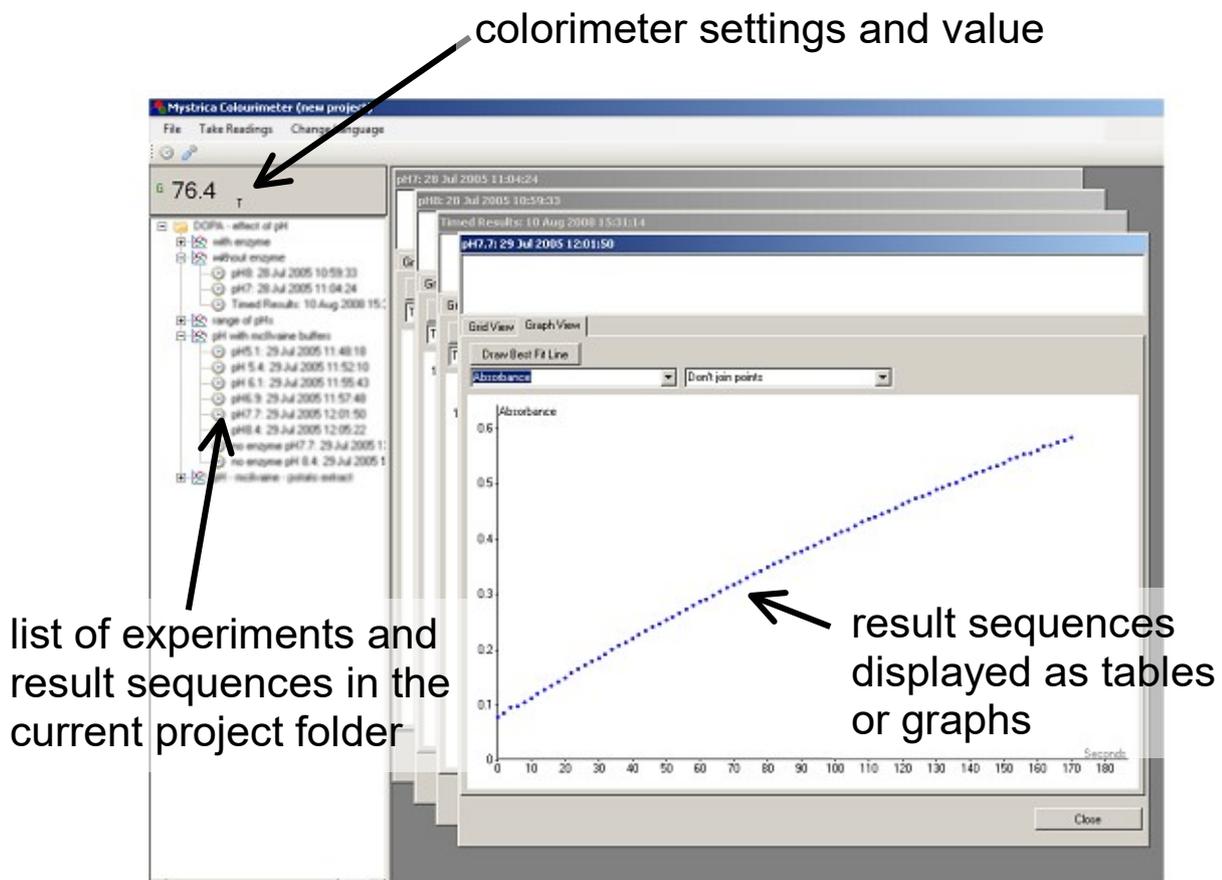
To install the software follow the on-screen instructions.

Using the software

Instructions and video demonstration clips can be found on the website, www.mystrica.com/Software

Press the power switch on the colorimeter to switch on.

The programme screens display information as shown below.

colorimeter settings and value

list of experiments and result sequences in the current project folder

result sequences displayed as tables or graphs

Creating a new project

A project folder contains a set of related experiments. Each experiment can contain any number of sequences of data. The name of a project could be for example the name of the person whose work this is or a general title for a set of related experiments.

The first time the programme is started an empty project folder is opened, (called 'Colorimeter Project' - right click on this folder to rename it). Subsequently the programme will always open with the project folder that was last used. The 'Files' option on the menu bar can be used to create a new project, to select and open an existing project, and to save the current project.
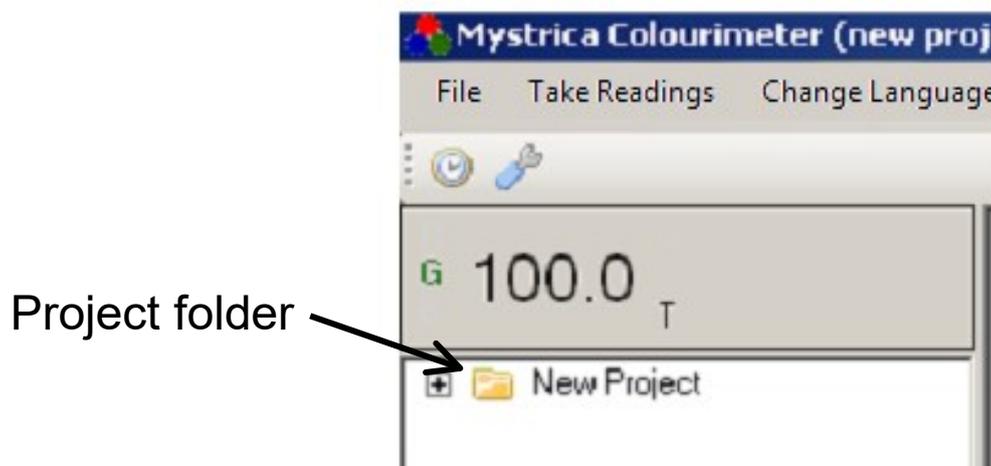
Project folder

The left side of the screen displays, below the current readings and settings from the colorimeter, a list of the experiments and data sequences contained in the project folder, (double click the project folder and experiment files to view these).
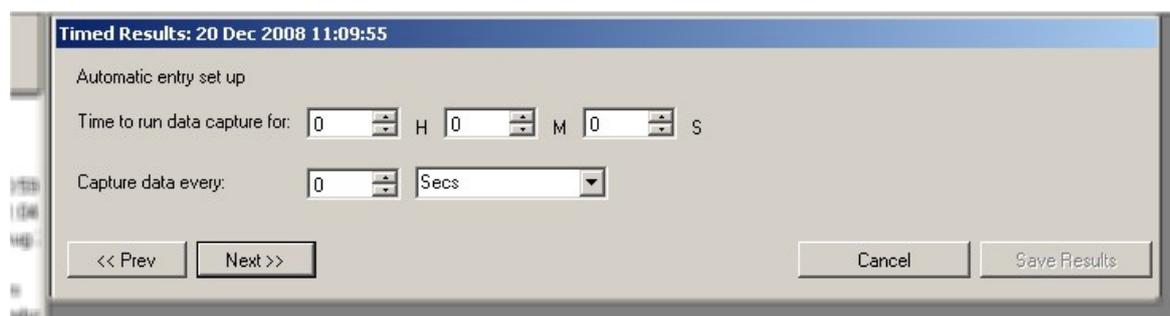
Creating a new experiment

Right click on the project folder and click 'New Experiment'. The box shown below will appear and a title and any other information can be entered.

The experiment file can contain any number of sequences of results collected from the colorimeter.

Preparing to collect data

Right click the experiment file. The box shown below will appear.

Selecting 'New Continuous Reading' allows data to be collected in a continuous stream for however long is set. 'New Separate Events' allows capture and storage of only the current value from the colorimeter.

Continuous readings

When 'New Continuous Reading' is selected the box shown below appears. You can enter a name for the sequence of results you are about to collect, the data and time are optional but it is usually good practice to leave these. The 'Description' box can be used to give details of the sequence, concentrations of reactants, temperature, pH, etc.
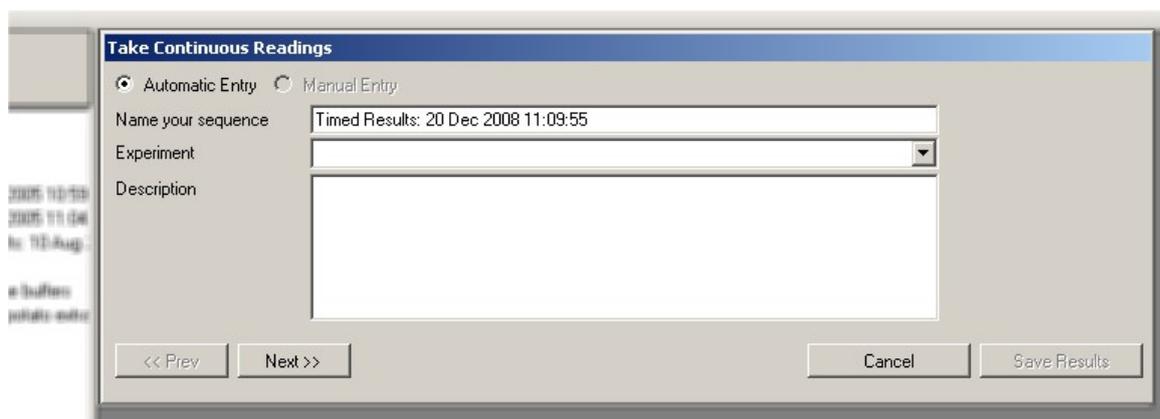
When 'Next' is clicked the box shown below appears. Use this to enter the length of time you want to collect data for, (**H**ours/**M**inutes/**S**econds), and the interval between data points.


Click 'Next' then on the next page click 'Take Readings' to start collecting data.

Displaying results as Tables or Graphs

The data can be displayed as a table or graph, (except when text is entered using Separate Events).

In graph view you can select to display the y-axis as either Transmittance or Absorbance and to join the points with straight lines, curves or not at all.

Data collection can be stopped prematurely, discarded, saved or exported as a .csv file to a selected location by clicking the labelled buttons.
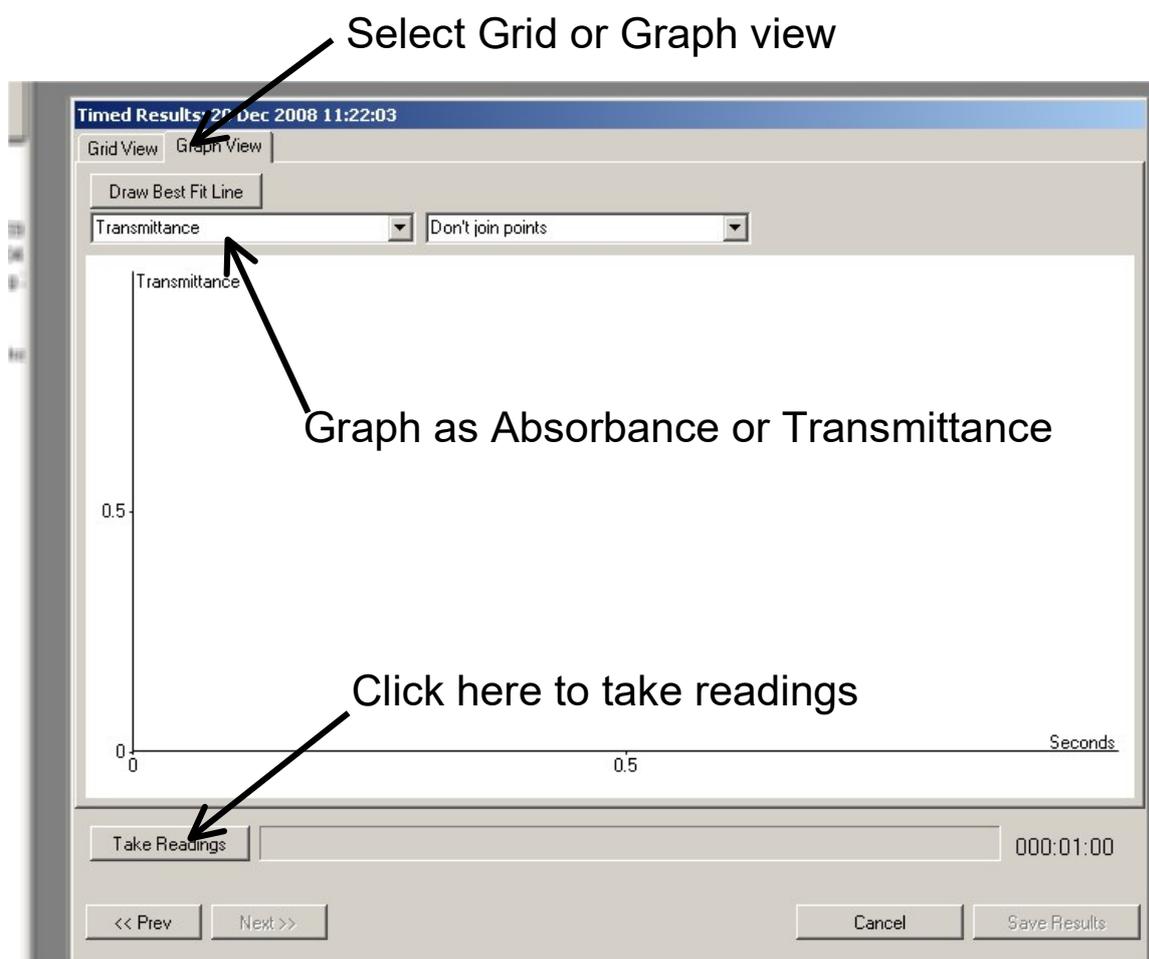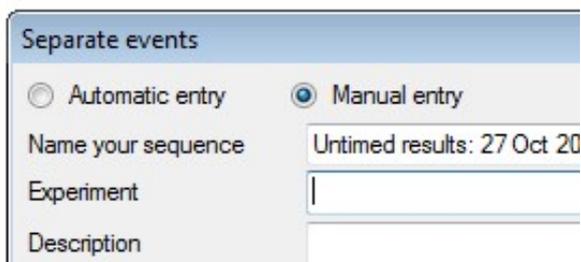
Separate Events

The procedure for Separate Events is similar to that for Continuous Readings except that you will be asked to select whether the readings should be associated with a numerical value or with text. If numeric the data captured can be displayed as a graph with the numeric values on the x-axis. If text the readings will only appear as a table. When you click 'Take Readings' only the current value from the colorimeter will be recorded as a single, discrete entry.

Manual Entry

In the 'Separate Events' box there is the option to enter both the x-axis values and the colorimeter readings, ie without using the current readings from the colorimeter.

Separate events

○ Automatic entry   ● Manual entry

Name your sequence   Untimed results: 27 Oct 20

Experiment |

Description

Drawing lines of best fit

A straight line of best fit can be drawn through any number of points on a graph. Select the points by clicking them then click 'Draw Best Fit Line'. The equation will be displayed in the form **y = ax + b** where **a** is the slope of the line and **b** is the intercept of the line on the y axis.

More information about using the software
can be found at

www.mystrica.com/Software

<u>Federal Communications Commission Statement</u>
This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.
NOTE: The manufacturer is not responsible for any radio or TV interference caused by unauthorized modifications or changes to this equipment. Such modifications or changes could void the user's authority to operate the equipment.
NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

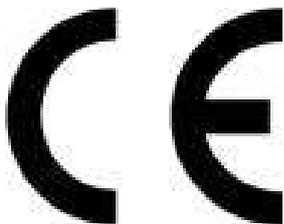The Mystrica colorimeter 2.0 has been tested and found to comply with harmonised standards:
EN 60950-1: 2006+A11:2009+A1:2010+A12:2011
EN 301 489-01 V1.9.2: 2011
EN 301 489-17 V2.2.1: 2012
EN 300 328 V1.8.1: 2012

Test certificates can be viewed at www.mystrica.com

FCC ID: 2AC8AMYS2

Email: enquiries@mystrica.com

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