CRI App

1.5.10

CRI App™ Manual

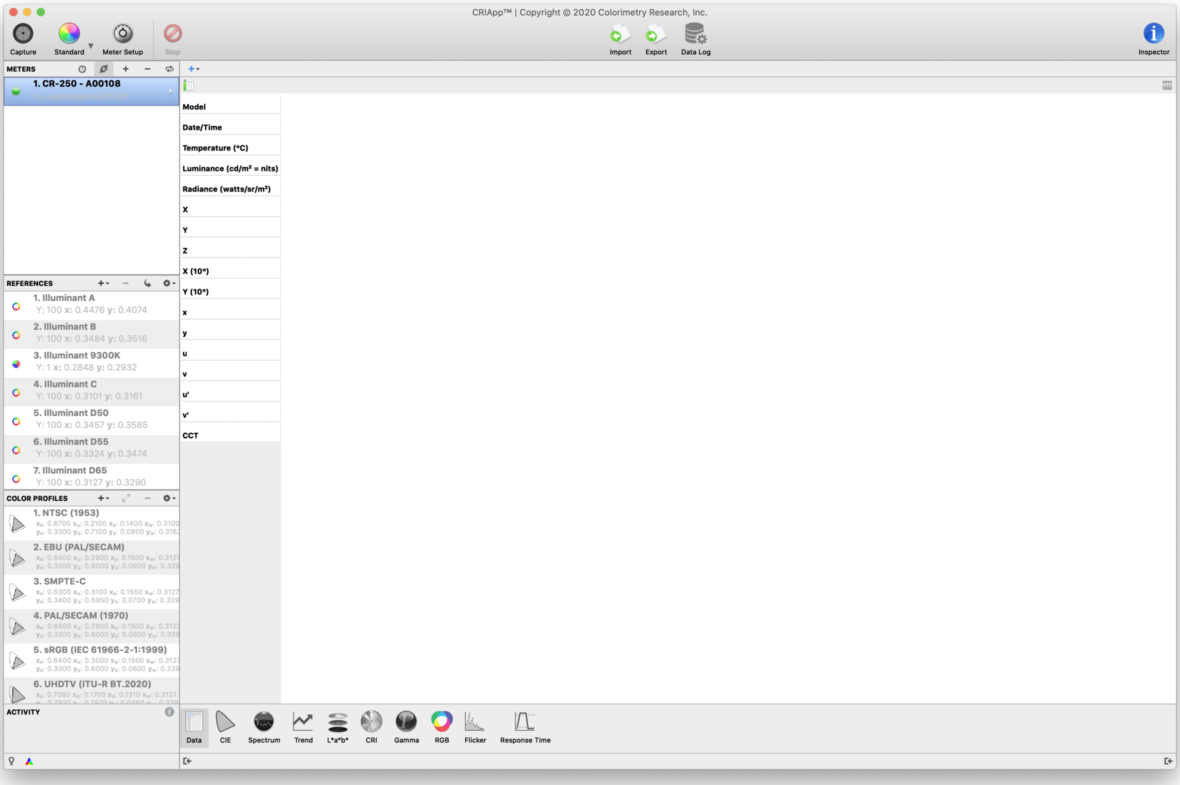


Figure 1 CRI App

The CRI App software application is a streamlined, cross-platform, user-centric assistant used to perform photometric, colorimetric and temporal analysis. It provides a familiar workspace regardless of the platform used. Installations are available for OS X and Windows operating systems.

- **Cross Platform:**

The working environment is the same in every platform while taking advantage of features specific to the host operating system.

- **Intuitive:**

The Interface is designed with a user-friendly approach allowing controls at your fingertips, not hidden away in menus or complex preferences.

- **Connectivity:**

The software is engineered to support simultaneous data capture from multiple connected instruments based on the contextual task at hand. Select an instrument to take a reading or simultaneously use all open instruments.

- **Data Visualization:**

Measurements are presented in a customizable tabular grid or easy to read charts. The software supports multiple types of measurements and co-exists gracefully within the same streamlined interface. All data and graphs can be copied or exported easily into your own spreadsheet application for further analysis and custom report generation.

See also

Measurements, Views, Export

- **Spectral Auto Interpolation:**

The spectral data view supports automatic interpolation of spectral data so that it provides seamless comparison between unlike spectra.

See also

Spectrum View

- **CRI & Gamma:**

Color Rendering Index visualization and gamma measurement mode is available

See also

CRI View, Gamma View

Overview

This manual is divided into three parts

Getting Started:

A set of short tutorials on how to get started with CRI App

- Section Installation and Setup discusses how to download and install the application for your platform.
- Section Walkthrough walks you through capturing your first measurement quickly.

Exploring the User Interface:

All the information you need to use the CRI App's features effectively.

- Section Features lists all the available features in the application.
  - Section Meters
  - Section Workspace
  - Section Measurements
  - Section References
  - Section Color Profiles
  - Section Activity
- Section Tools & Utilities discusses the various accompanying tools and utilities.

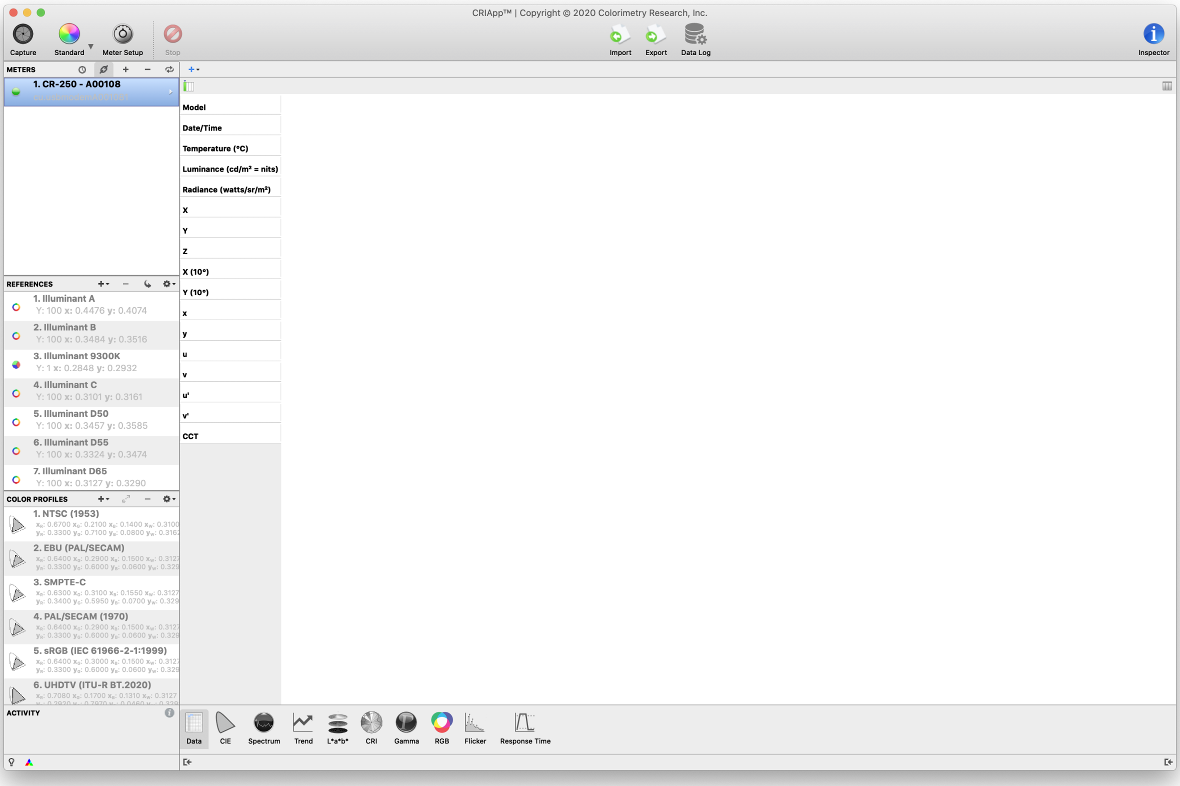
Getting Help:

- Section FAQ lists the possible solutions to common questions.
- Section Trouble Shooting & Support lists various trouble shooting scenarios.

Chapter 1

Introduction

CRI App™ Manual



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Chapter 2

Installation and Setup

This section explains how to install the instrument driver, the software applications and the Software Development Kit (SDK).

Note

> This section is only valid for Microsoft Windows systems. OS X includes native driver support for USB-Serial devices.

2.1 Windows Drivers

For all versions of Windows (Except Windows XP), a software driver wizard will install the appropriate 32-bit or 64-bit version of the USB-Serial driver. The manually install the driver, run `DPInst.exe` located in the following installation directory.

%PROGRAMFILES%\Colorimetry Research\Drivers

Where, %PROGRAMFILES% is typically C:\Program Files

For Windows XP, the installer copies the driver setup information file into the location of your windows directory.

%WINDIR%\inf\Colorimetry Research\usb_dev_serial.inf

→Windows Folder

→inf

→Colorimetry Research

→usb_dev_serial.inf

Where, %WINDIR% is typically C:\Windows

2.2 Windows Driver Installation

2.2.1 How to Access Device Manager From the Control Panel

Device Manager is a **Control Panel** application that allows you to manage devices and drivers on your system. You can use Device Manager to uninstall devices and driver packages with some limitations. Typically, an end-user does not use Device Manager to uninstall devices or driver packages, but might have to use Device Manager to troubleshoot problems they might encounter on their computer.

One of the easiest ways to access Device Manager in Windows is from the **Control Panel**.

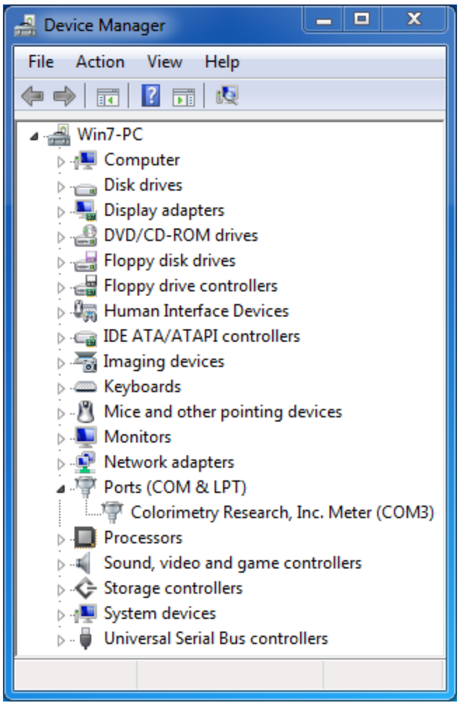

Figure 2.1 Device Manager

1. Click on the **Start** button and then choose **Control Panel**.
2. Click on the **System and Security** link.

   Note

   If you're viewing the *Large icons* or *Small icons* view of **Control Panel**, you won't see this link. Simply click on **Device Manager** and then proceed to Step 4.

3. In the **System and Security** window, click on the **Device Manager** link located under the System heading.
4. You can now use **Device Manager** to update device drivers, view the system resources that a hardware device is using, etc.

2.2.2 Using Device Manager to Uninstall Virtual COM Ports

Note

You must have administrator privileges to uninstall a device or driver package by using Device Manager.

Figure 2.2 Uninstall COM Port

To uninstall a device by using **Device Manager**, follow these steps:

1. Start **Control Panel**, click **Hardware and Sound**, and then click **Device Manager**. or refer How to Access Device Manager From the Control Panel
2. Expand the node *"Ports (COM & LPT)"*, right-click the virtual COM Port entry, and click Uninstall.
3. On the *Confirm Device Removal* dialog box, click the *Delete the driver software for this device* option to delete the driver package that was used for the device. Then, click OK to start the uninstall process.
4. When the uninstall process is complete, remove the device.

2.2.3 Using Device Manager to install/update Virtual COM Port drivers

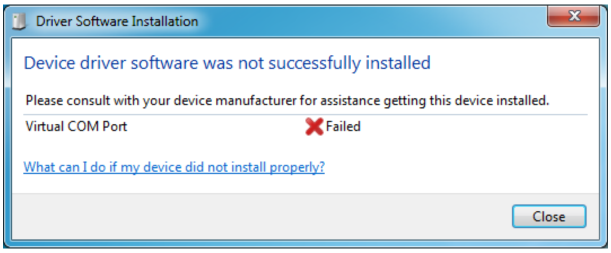

Figure 2.3 Driver software installation - Failed

Note

You must be logged on as an administrator to perform these steps. If you're prompted for an administrator password or confirmation, type the password or provide confirmation.

1. Open Device Manager by clicking the Start button, clicking Control Panel, clicking System and Security, and then, under System, clicking Device Manager.
2. In the list of hardware categories, find the device that you want to update, and then double-click the device name.

3. Click the Driver tab, click Update Driver, and then follow the instructions.

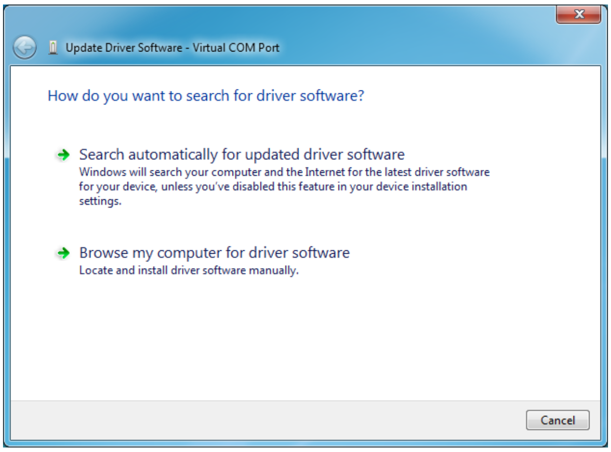

Figure 2.4 Update driver software wizard

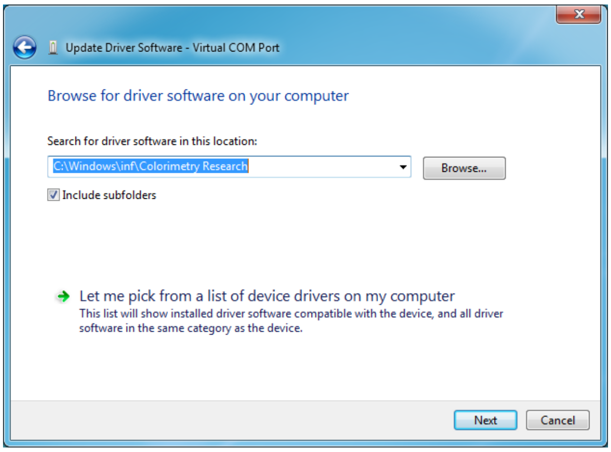

Figure 2.5 Browse for driver software

4. In the update driver software wizard, select the option *"Browse my computer for driver software"*

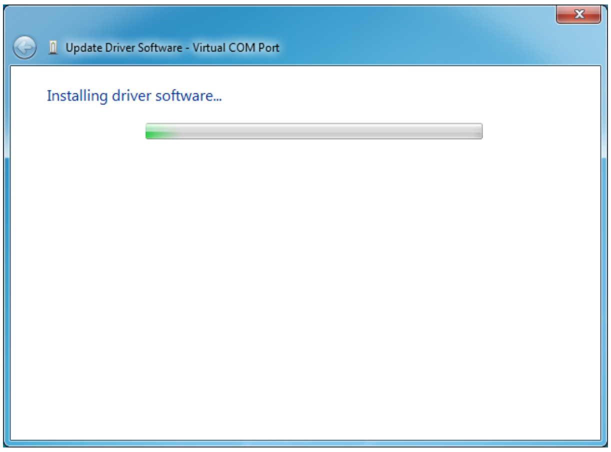

Figure 2.6 Installing driver software

5. In the browse for driver software on your computer, select the folder where the driver software exists.

Windows Drivers

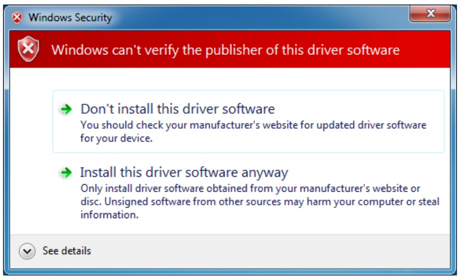

Figure 2.7 Driver software publisher verification

6. Windows Security will warn that it can't verify the publisher of this driver software. Select *"Install this driver software anyway"*
7. Note the COM port assigned to the Virtual COM device. This will be the port the application will need to connect to.

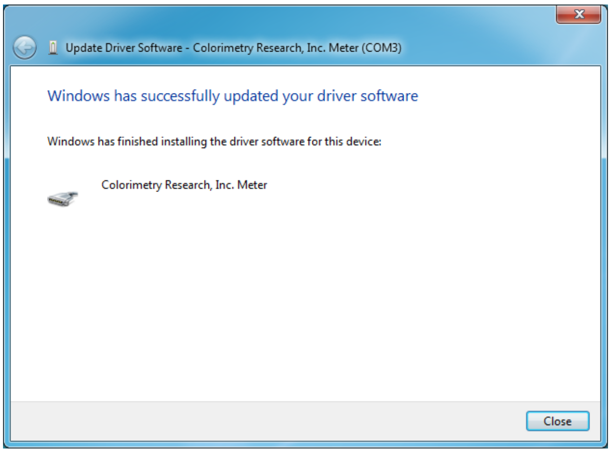

Figure 2.8 Update driver software - Successful

Chapter 3

Walkthrough

- Double click on the CRI App icon to launch the application.
- Click on the '+' action button in the meters pane to add an instrument. The application should identify the first instrument connected via USB.

  See also

  Add/Remove & Select
- Click on Capture along the top toolbar to take a reading.
- You can choose different measurement options from the top toolbar button (colored circle) which defaults to Standard.
- The CIE chart can be displayed by selecting the CIE View action icon at the bottom. Similar options are located at the bottom for CRI View, L∗a∗b∗ View and Flicker View Flicker.
- For continuous measurements click on the 'clock' action icon next to the '+' action. The pull down settings, offer options for starting measurements that are continuous or triggered at regular intervals.

  See also

  Timer
- Hitting the top toolbar button marked 'Export' gives you the option to export the data in CSV or text format.

  See also

  Export

Chapter 4

Features

4.1 User Interface (UX)

When you first launch CRI App, it opens up in a default Workspace.

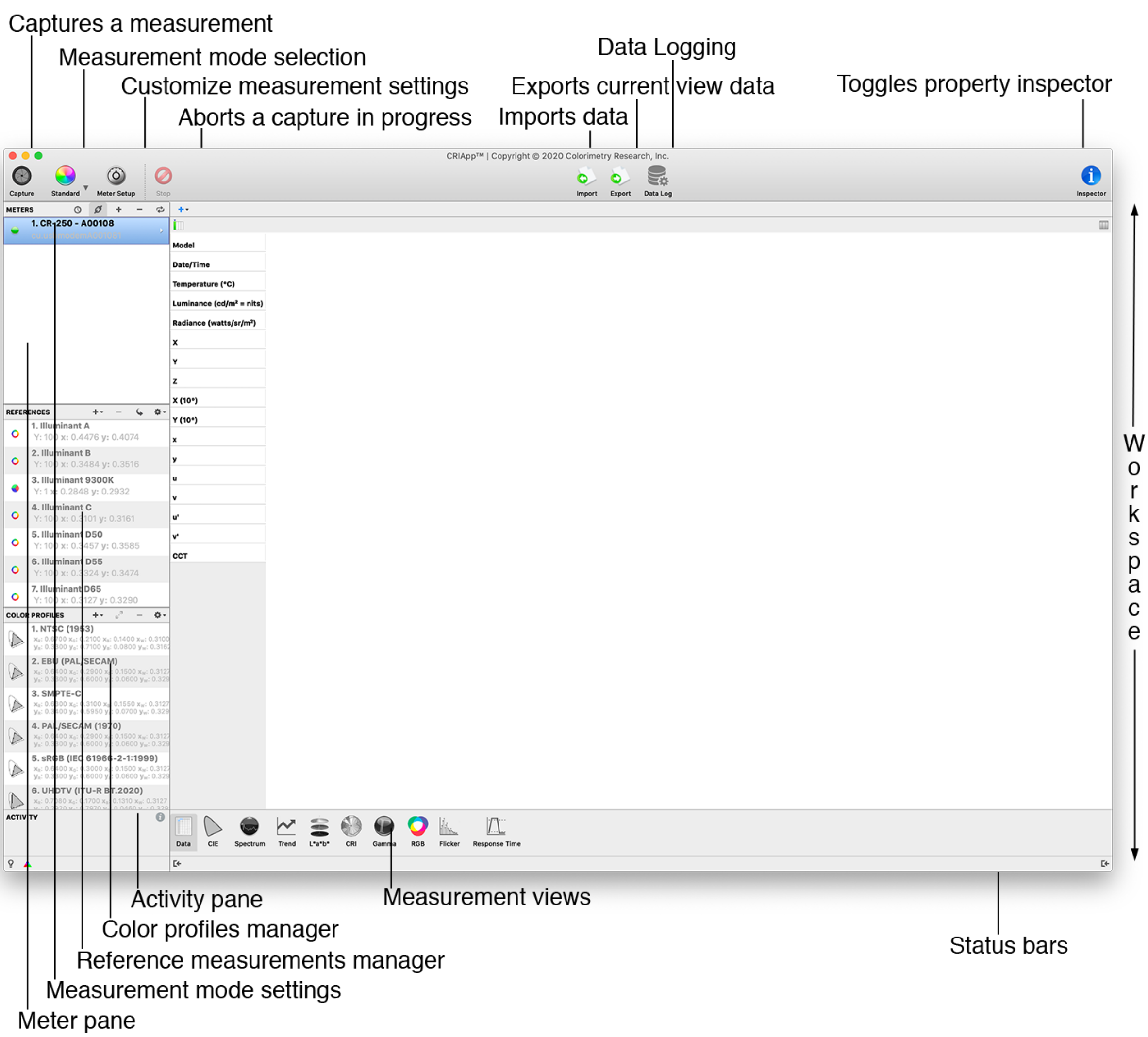

Figure 4.1 CRI App

The main window consists of the main menu, the application toolbar on the top and the status toolbar at the bottom. The main section is divided into the side bar on the left, view section and the inspector on the right.

The side bar is a container for the Meters, Measurements Panel, References, Color Profiles and the Activity.

- Following is the list of all the components in the application.
  - Meters - Meter manager
  - Workspace - Workspace
  - Measurements - The different measurement modes
  - References - Reference manager
  - Color Profiles - Color profile manager
  - Activity - Activity pane
- The main toolbar consists of the following actions.
  - Capture
  - Measurement Modes
  - Setup, Connect & Disconnect
  - Stop
  - Export
  - Data Log
  - Inspectors

Chapter 5

Meters

This section walks you through the different meter related tasks

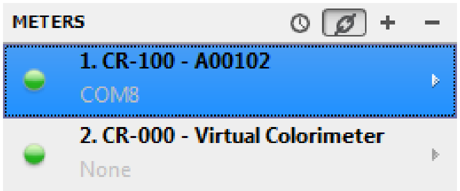

Figure 5.1 Meter pane

The following actions are available for the meter pane

- **Timer settings** - Continuous, repeated and timer based capture settings.

  See also

  Timer

- **Linking meters** - Link one or more instruments to allow simultaneous capture.

  See also

  Linking meters

- **Add** - Add a new instrument to the list.

  See also

  Add/Remove & Select

- **Remove** - Remove the selected instrument from the list.

  See also

  Add/Remove & Select

5.1 Add/Remove & Select

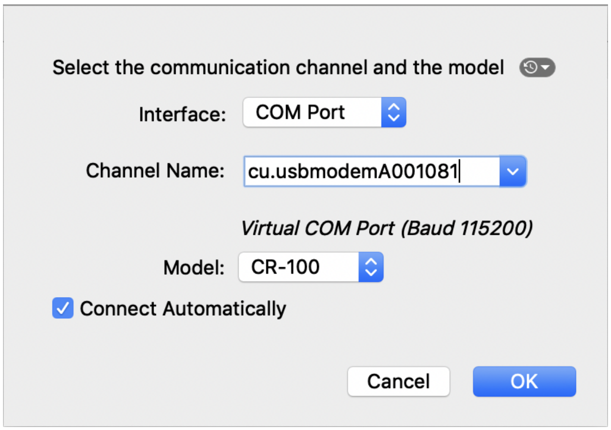

Figure 5.2 Add instrument

- **Interface**
  - **COM Port** - USB port Serial port
  - **Network** - Ethernet
- **Channel name** - The name of the USB port or an IP address for a network connection.
- **Model** - Selects the appropriate driver to connect to the instrument
- **Connect automatically** - Automatically attempts connecting to the instrument.

During initialization the CRIApp attempts to detect instruments any of the USB ports. If a colorimetry research instrument is detected, the CRI App connects and inserts it into the meter list. If no valid instrument is detected a Virtual Colorimeter is automatically created and added to the meter list.

To insert a new instrument

Click on the tool button with the '+' icon. Select the model as "CR-000" to add a virtual colorimeter.

To remove an instrument

Select the instrument in the meter pane. Click on the tool button with the '-' icon. You will be prompted to confirm your action.

Selecting an instrument

Selecting an instrument allows you to operate on the instrument such as highlight for removal or to modify its setup or initiate a capture.

When the instruments are not linked selection also indicates the current active instrument.

5.2 Setup, Connect & Disconnect

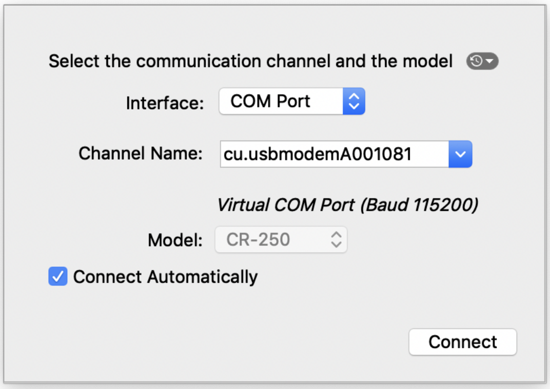

Figure 5.3 Connection settings

Adding an instrument as described by the Add/Remove & Select section will also allow you to automatically attempt connecting. If an incorrect port has been selected, an option to select a different channel or port will be allowed.

To setup parameters for measurement Select the instrument in the meter list. Click the setup icon in the toolbar. You can also reach this setup by double-clicking your mouse on the meter in the list.

Note

Instrument Setup parameters remain in affect until the instrument is powered down.

5.3 Capture

The capture button in the main toolbar is enabled if there are connected meters. This allows you to start capturing.

5.4 Stop

When a capture is in progress the Abort button is enabled to allow stopping the currently running activity.

Note

Some of the older firmware does not supporting aborting of measurements. The busy animation on the meter pane indicates of the meter is still busy. This aborts the capture activity and allows you to continue capturing with a different instrument.

5.5 Timer

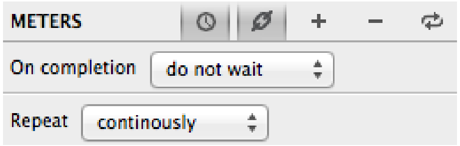

Figure 5.4 Timer: Continuously without delay

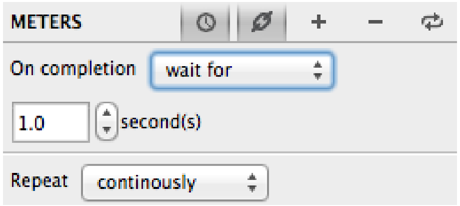

Figure 5.5 Timer: Continuously with delay

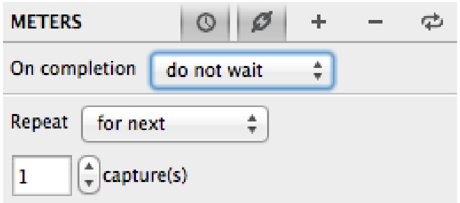

Figure 5.6 Timer: Repeat without delay

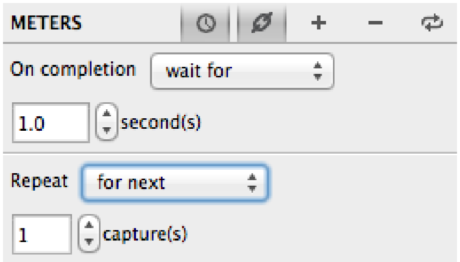

Figure 5.7 Timer: Repeat with delay

The timer settings enable taking several consecutive measurements, repeated measurements with or without precise timed intervals.

Note

Timed measurements are only available in the Standard measurement mode.

5.6 Linking meters

Linking meters together allows the capture button to simultaneous start a capture from all open or connected meters in the list.

Note

Linking of meters is only available in the Standard measurement mode.

5.7 Virtual Colorimeter

The CRI App allows you to simulate measurement data for the purpose of evaluation using a Virtual Colorimeter with model CR-000.

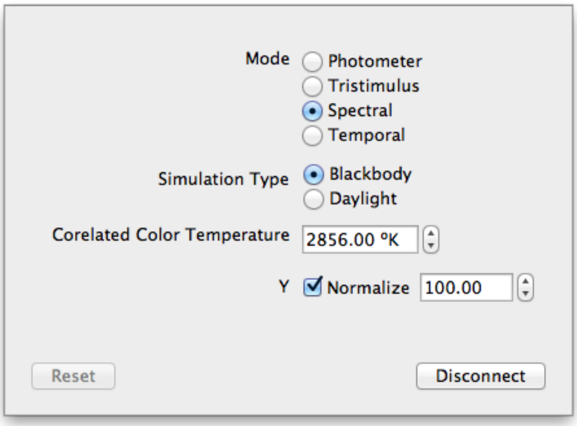

Figure 5.8 Virtual Colorimeter Setup

- **Mode** - The mode option selects the type of measurement simulated
  - **Photometer** - Creates a measurement with only the photopic value using the normalization settings specified
  - **Tristimulus** - Creates a color measurement with X, Y and Z. This uses the CCT and normalization settings specified
  - **Spectral** - Creates a spectral measurement specified by the spectral simulation type
  - **Temporal** - Creates a temporal measurement specified by the temporal simulation type
- **Simulation Type** - Temporal mode waveform simulations
  - **ICDM Flicker** - Creates temporal measurement specified by the ICDM specs for verifying flicker calculations.
  - **Sine** - Creates a temporal measurement based on a sine wave.
  - **Cosine** - Creates a temporal measurement based on a cosine wave.
  - **Square** - Creates a temporal measurement based on a square wave.
  - **Triangle** - Creates a temporal measurement based on a triangular wave.
- **Simulation Type** - Spectral waveform simulations
  - **Blackbody** - Creates spectral measurement using a blackbody simulator.
  - **Daylight** - Creates a spectral measurement using a planckian daylight simulator.
- **Correlated Color Temperature** - Specifies the color temperature in °Kelvin of the measurement for **Tristimulus** and **Spectral** modes.
- **Normalize** - Normalizes the measurement (other than temporal) using the normalization level specified.

5.8 CR-100/CR-200 Tristimulus Colorimeter/Photometer

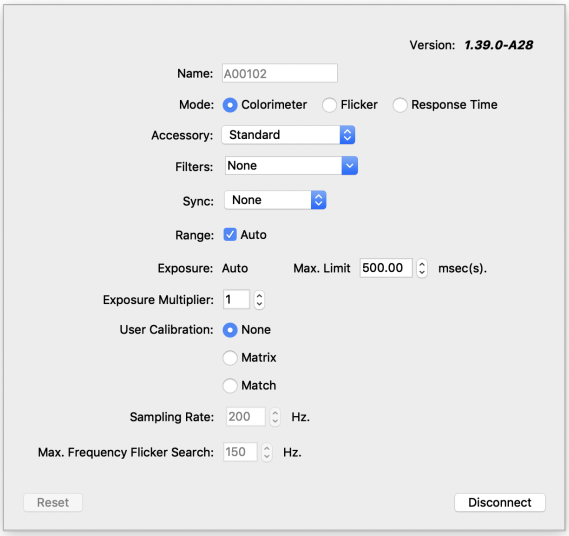

Figure 5.9 CR-100/CR-200 Setup - Colorimeter Mode

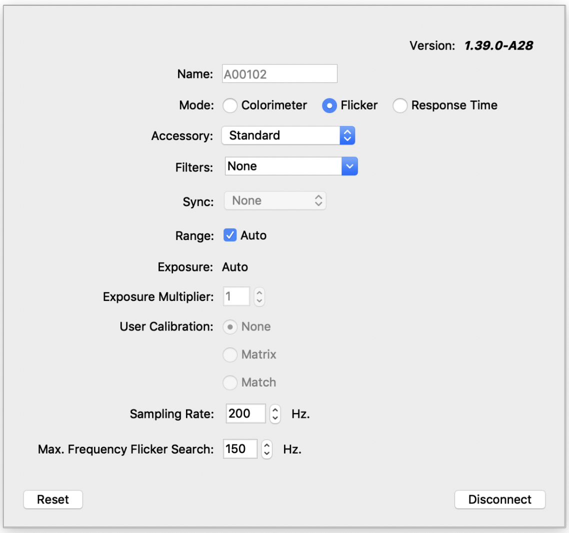

Figure 5.10 CR-100/CR-200 Setup - Flicker Mode

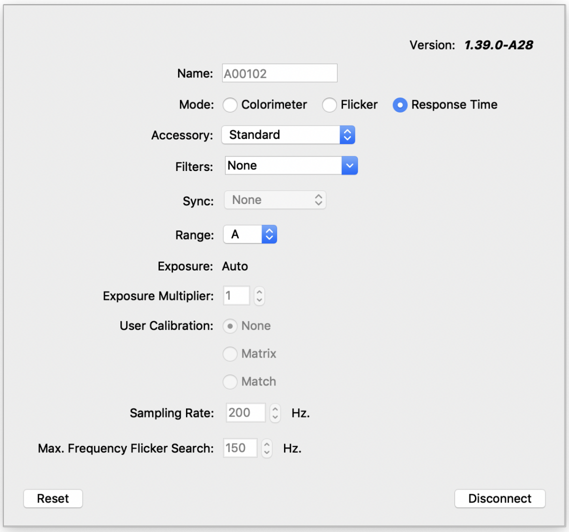

Figure 5.11 CR-100/CR-200 Setup - Response Time Mode

- **Name** - A friendly name that will be displayed in the meter pane to easily identify the instrument
- **Mode** - The mode option selects the measurement data type
  - **Colorimeter** - Captures a tristimulus measurement
  - **Flicker** - Captures a temporal measurement
- **Accessory** - Accessory used. The accessory selection specifies the units of the photometric results.
- **Filters** - ND (Neutral Density) Filter used

  Note

  A maximum of 3 filters can be used simultaneously with a given accessory.
- **Sync** - Sync settings
  - **None** - The capture is not synchronized the frequency of the light signal
  - **Automatic** - Automatically detects the frequency of the light signal and synchronizes the capture
  - **NTSC** - Uses fixed 60Hz frequency to synchronize the capture of the light signal
  - **PAL** - Uses a fixed 50Hz frequency to synchronize the capture of the light signal
  - **CINEMA** - Uses a fixed 48Hz frequency to synchronize the capture of the light signal
  - **Manual** - Uses custom frequency to synchronize the capture of the light signal
- **Range** - Electronic range settings
  - **Auto** - Automatically selects the range
  - **Manual** - Manually selection of the ranges A ,B, C or D
- **Exposure** - Exposure settings
  - **Auto** - Automatically selects the exposure
  - **Manual** - Manual exposure adjustments are available on if the Range D is selected.
- **Maximum Auto Exposure Limit** - Limits the maximum auto exposure
- **Exposure Multiplier** - Makes the exposure a multiple using the specified multiplier
- **User Calibration**

  - **None** - No user calibration is required
  - **Matrix** - Selects the user calibration matrix to be used.
  - **Match** - Selects the user match calibration to be used.
- **Sampling Rate** - Sampling rate in Hz. for the temporal measurement.
- **Max. Frequency Flicker Search** - Limits the flicker frequency search to the selected value.

5.9 CR-110 Flicker Detector/Photometer

- **Mode** - The mode option selects the measurement data type
  - **Photometer** - Captures a photometric measurement
  - **Flicker** - Creates a temporal measurement suitable for flicker analysis
  - **Response Time** - Creates a temporal measurement suitable for response time analysis
- **Accessory** - Accessory used. The accessory selection specifies the units of the photometric results.
- **Filters** - ND (Neutral Density) Filter used

  Note

  A maximum of 3 filters can be used simultaneously with a given accessory.

5.9.1 Photometer mode

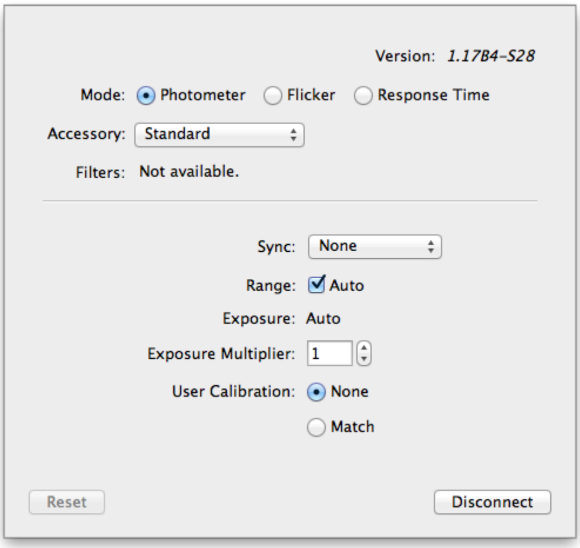

Figure 5.12 CR-110 Setup - Photometer Mode

- **Sync** - Sync settings
  - **None** - The capture is not synchronized the frequency of the light signal
  - **Automatic** - Automatically detects the frequency of the light signal and synchronizes the capture
  - **Manual** - Uses custom frequency to synchronize the capture of the light signal
- **Range** - Electronic range settings

  - **Auto** - Automatically selects the range
  - **Manual** - Manually selection of the ranges A ,B, C or D

- **Exposure** - Exposure settings
  - **Auto** - Automatically selects the exposure
  - **Manual** - Manual exposure adjustments are available on if the Range D is selected.

- **Exposure Multiplier** - Makes the exposure a multiple using the specified multiplier

- **User Calibration** - User calibration setup
  - **None** - No user calibration is required.
  - **Match** - Selects the photometric user match calibration to be used.

5.9.2 Flicker mode

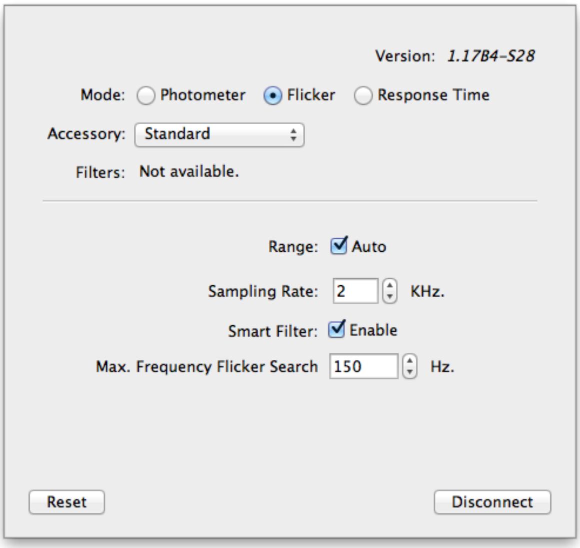

Figure 5.13 CR-110 Setup - Flicker/Response Time Mode

- **Range** - Electronic range settings
  - **Auto** - Automatically selects the range
  - **Manual** - Manually selection of the ranges A ,B, C or D

- **Sampling Rate** - This is the sampling rate of the temporal measurement

- **Smart Filter** - Enable or disable the adaptive electronic smart noise-filtering algorithm to reduce high frequency noise

- **Max. Frequency Flicker Search** - Limits the flicker frequency search to the selected value.

Note

For response time mode the Range: Auto is not available. Manual selection of an appropriate range is required.

5.10 CR-250 Spectroradiometer

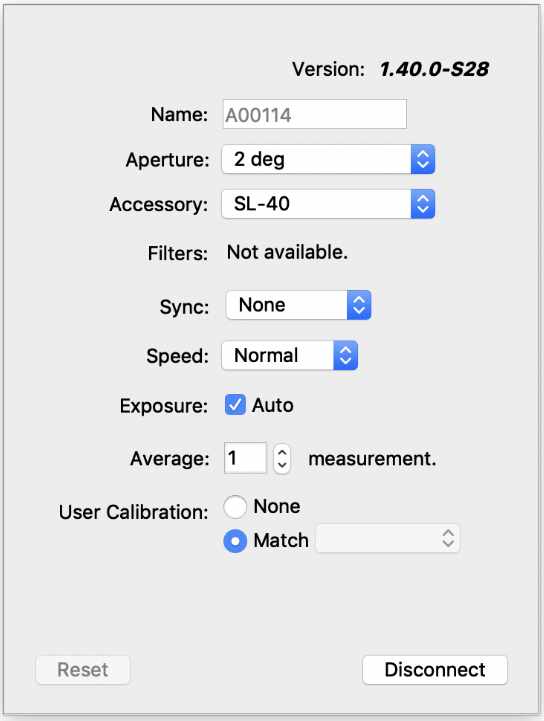

Figure 5.14 CR-250 Setup

- **Name** - A friendly name that will be displayed in the meter pane to easily identify the instrument
- **Aperture** - Aperture used.
- **Accessory** - Accessory used. The accessory selection specifies the units of the photometric results.
- **Filters** - ND (Neutral Density) Filter used

  Note

  A maximum of 3 filters can be used simultaneously with a given accessory.
- **Speeds** - Speed settings
  - **Slow** - Slow for low light measurements
  - **Normal** - Standard
  - **Fast** - Fast
  - **2xFast** - Twice the speed of Fast
- **Exposure** - Exposure settings
  - **Auto** - Automatically selects the exposure
  - **Manual** - Manual exposure adjustments are available.
- **Average** - Averages the exposure to a multiple using the specified multiplier. The average measurements create a loop that repeats and average the same reading
- **User Calibration**
  - **None** - No user calibration.

- **Match** - Selects the user spectral match calibration to be used.

- **Sensor Heater** - (Optional) sensor heater option for measurement in low ambient temperature
  - **Off** - Heater is off.
  - **On** - Heater is always on.
  - **Auto** - Automatically controls the heating.

Chapter 6

Workspace

6.1 General

The workspace is serialized to a proprietary file format with .chroma extension. All measurements, views and settings are serialized to this file.

Closing the application Window

When a measurement activity is in progress, the application cannot be closed without the completion of the activity. A warning **"The CRI App is busy! Please let the application finish all pending tasks before closing."**

If the workspace contains measurements that have not been saved the application also prompts to save the measurements when closing. **"The current workspace has not been saved. Do you want to continue?"**

6.1.1 Open

Open an existing workspace which is serialized to a .chroma file format. All the measurements and the workspace settings are loaded into the current workspace.

Note

CRIApp remembers the location of the last file that was opened.

6.1.2 Save

Saves the current workspace to a .chroma file format.

Note

CRIApp remembers the location of the last file that was saved.

6.1.3 Close

Removes all measurements from the current workspace but leaves the settings intact.

6.2 Views

6.2.1 Data View

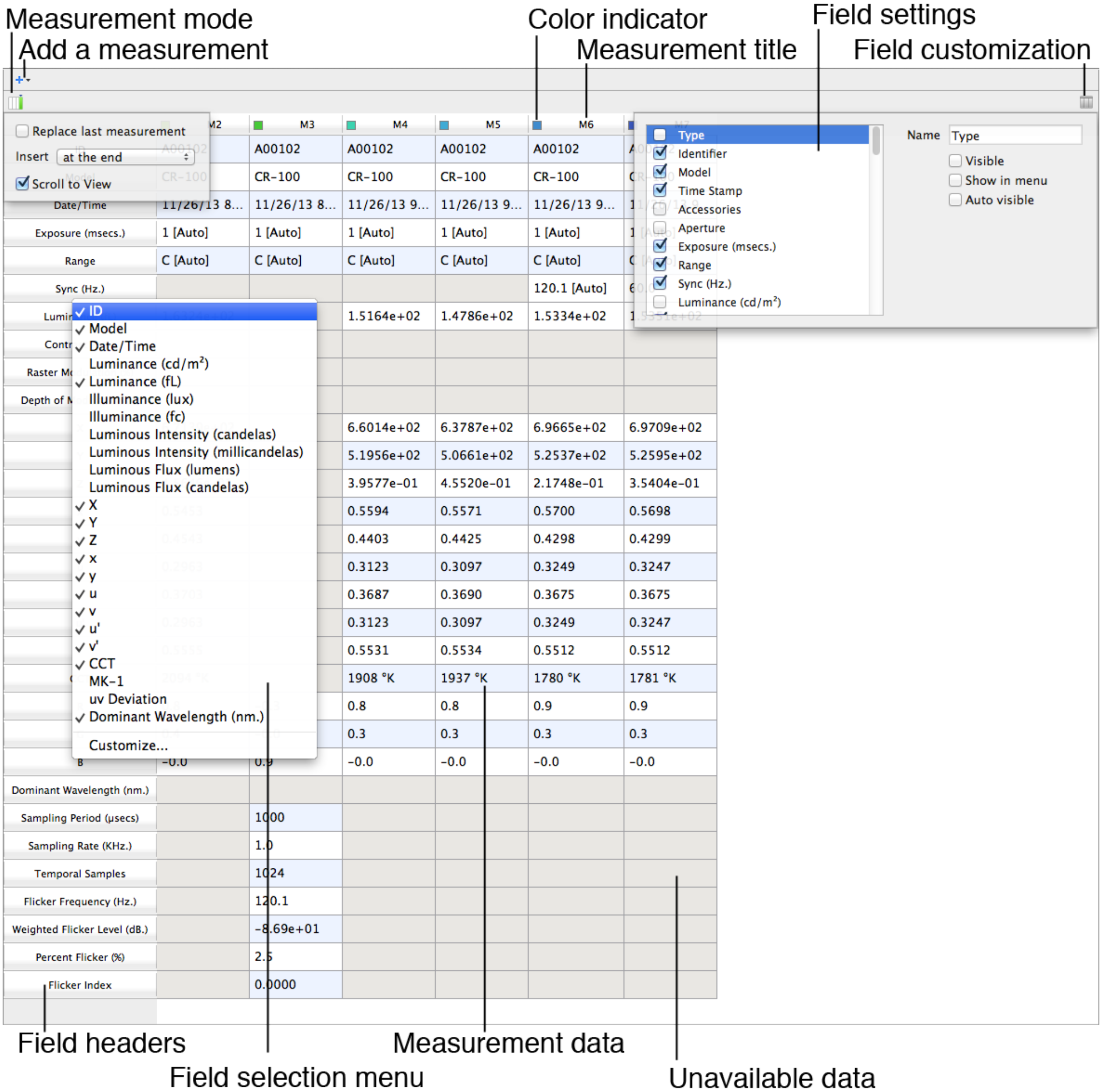

Figure 6.1 Measurement Data View

- The data view actions
  - **Replace last (n) measurement(s)** - Recycle the workspace by replacing the last n measurements
  - **Insert position** - Select the insert position "<i>in the beginning</i>" or "<i>at the end</i>"
  - **Scroll to view** - Always scroll to the last added measurement. This is important when adding measurements to the end will hide the measurement from view.
  - **Customize data fields** - Select the measurement fields to be displayed in the data view

Measurement data is displayed in a table as a row of customizable fields. Each column represents a measurement.

Each field has the following properties

- **Visible** - This toggles the visibility of the data field in the measurement field.
- **Show in menu** - This adds a quick access to the header context menu which is available by right clicking the field name header.
- **Auto visible** - This setting displays the row in the measurement data table only if the new measurement contains a valid entry.

  For e.g. If a contrast field was selected and Auto visible was enabled. The contrast field would only be displayed if the measurement was a valid Contrast.
- **Format** - Some numeric fields and date/time fields support custom formatting
  - For Numeric Fields
    - **Default** - Default numeric format, it could be either of the following formats
    - **Decimal Notation** - Displays the field in a decimal notation
    - **Scientific Notation** - Displays the field in exponential notation.
  - For Date/Time Fields
    - **Default** - Default date/time format, it could be either of the following formats. The date is displayed as **month/day/year**, while the time is displayed as **hours:minutes:seconds AM/PM**
    - **Date/Time** - Displays the date and time.
    - **Time/Date** - Displays the time and date.
    - **Date** - Displays only the date.
    - **Time** - Displays only the time.

Following is the list of data fields and its description which are supported by the application.

- **Type** - Measurement type e.g. Standard, Contrast, etc.
- **Identifier** - Instrument identifier
- **Model** - Instrument model number
- **Time Stamp** - Date and Time stamp of the captured data
- **Accessories** - Accessories used during measurement capture. This includes the accessories and the filters used.
- **Aperture** - Optical aperture used
- **Exposure (msecs.)** - The exposure time expressed in milliseconds. If the exposure was automatically selected then *[Auto]* will appear after the actual exposure time. The exposure multiplier will be appended at the end. For e.g. 3 [Auto] x 4 This indicates that a 3 second exposure was selected automatically and was multiplied 4 consecutive times.
- **Speed** - Speed settings used. This setting is available for only certain types of instruments.
- **Range** - Electronic range used. This setting depends on the instrument mode used during capture. If auto range was selected *[Auto]* will appear after the range used. For e.g. C [Auto] Range C was automatically selected.
- **Sync (Hz.)** - Frequency at which the measurement exposure was synced during capture expressed in Hertz. If manual sync was used, the user set sync frequency is displayed. If sync mode was Auto then *[Auto]* will be displayed after displaying the sync frequency in Hertz. For e.g. 120 [Auto]
- **Temperature (℃)** - The internal temperature during capture expressed in Celsius (Centigrade).
- **Temperature (℉)** - The internal temperature during capture expressed in Fahrenheit.
- **Luminance (cd/m^2 = nits)** - The Luminance expressed in SI units: candelas/meter^2 or nits. This value depends on the accessory used.

See also

Luminance calculations

- **Luminance (fL)** - The Luminance expressed in non SI units: footLamberts. This value depends on the accessory used.

See also

Luminance calculations

- **Illuminance (lux)** - The Illuminance expressed in lux. This value depends on the accessory used.

See also

Illuminance calculations

- **Illuminance (fc)** - The Illuminace expressed in foot candles. This value depends on the accessory used.

See also

Illuminance calculations

- **Luminous Intensity (candelas)** - The Luminous Intensity expressed in candelas. This value depends on the accessory used.

See also

Luminous Intensity calculations

- **Luminous Intensity (millicandelas)** - The Luminous Intensity expressed milli candelas. This value depends on the accessory used.

See also

Luminous Intensity calculations

- **Luminous Flux (lumens)** - The Luminous Flux expressed in lumens. This value depends on the accessory used.

See also

Luminous Flux calculations

- **Luminous Flux (candelas)** - The Luminous Flux expressed candelas. This value depends on the accessory used.

See also

Luminous Flux calculations

- **Radiance (watts/sr/m^2)** - The Radiance expressed in: watts/sr/m^2. This value depends on the accessory used.

See also

Radiance calculations

- **Photon Radiance (photons/sr/m^2/sec)** - The Photon Radiance expressed in: photons/sr/m^2/sec. This value depends on the accessory used.

See also

Photon Radiance calculations

- **Irradiance (watts/m^2)** - The Irradiance expressed in watts/m^2. This value depends on the accessory used.

See also

Irradiance calculations

- **Photon Irradiance (watts/m^2)** - The Photon Irradiance expressed in watts/m^2. This value depends on the accessory used.

See also

Photon Irradiance calculations

- **Radiant Intensity (watts/sr)** - The Radiant Intensity expressed in watts/sr. This value depends on the accessory used.

See also

Radiant Intensity calculations

- **Photon Radiant Intensity (photons/sr/sec)** - The Photon Radiant Intensity expressed photons/sr/sec. This value depends on the accessory used.

See also

Photon Radiant Intensity calculations

- **Radiant Flux (watts)** - The Radiant Flux expressed in watts. This value depends on the accessory used.

See also

Radiant Flux calculations

- **Photon Radiant Flux (photons/sec)** - The Photon Radiant Flux expressed photons/sec. This value depends on the accessory used.

See also

Photon Radiant Flux calculations

- **Pho. Transmittance (%)** - Photometric transmittance expressed as a percentage value. This data is only available for Transmittance measurements.

See also

Transmittance calculations

- **Rad. Transmittance (%)** - Radiometric transmittance expressed as a percentage value. This data is only available for Transmittance measurements.

See also

Transmittance calculations

- **Pho. Reflectance (%)** - Photometric reflectance expressed as a percentage value. This data is only available for Reflectance measurements.

See also

Reflectance calculations

- **Rad. Reflectance (%)** - Radiometric reflectance expressed as a percentage value. This data is only available for Reflectance measurements.

See also

Reflectance calculations

- **Pho. Absorptance (%)** - Photometric absorptance expressed as a percentage value. This data is only available for Absorptance measurements.

See also

Absorptance calculations

- **Rad. Absorptance (%)** - Radiometric absorptance expressed as a percentage value. This data is only available for Absorptance measurements.

  See also

  Absorptance calculations

- **Pho. Optical Density (%)** - Photometric optical density expressed as a percentage value. This data is only available for Optical Density measurements.

  See also

  Optical Density calculations

- **Rad. Optical Density (%)** - Radiometric optical density expressed as a percentage value. This data is only available for Optical Density measurements.

  See also

  Optical Density calculations

- **Contrast Ratio** - The Contrast ratio. This data is only available for Contrast measurements.

  See also

  Contrast Ratio calculations

- **Raster Modulation (%)** - Raster modulation expressed as a percentage value. This data is only available for Contrast measurements.

  See also

  Raster Modulation (Weber Contrast) calculations

- **Depth of Modulation (%)** - Depth of modulation expressed as a percentage value. This data is only available for Contrast measurements.

  See also

  Depth of Modulation (Michelson Contrast) calculations

- **X** - Tristimulus Red (X_r and X_b)
- **Y** - Tristimulus Photopic (Y)
- **Z** - Tristimulus Blue (Z)
- **X (10°)** - Tristimulus Red (X_r and X_b) using 10° observer data. This data is only available for measurements that contain spectral data.
- **Y (10°)** - Tristimulus Photopic (Y) using 10° observer data. This data is only available for measurements that contain spectral data.
- **Z (10°)** - Tristimulus Blue (Z) using 10° observer data. This data is only available for measurements that contain spectral data.
- **x** - The CIE 1931 x coordinate. This data is only available for measurements that contain tristimulus data.

  See also

  CIE 1931 - xy calculations

- **y** - The CIE 1931 y coordinate. This data is only available for measurements that contain tristimulus data.

See also

CIE 1931 - xy calculations

- **x (10°)** - The CIE 1964 x coordinate using 10° observer data. This data is only available for measurements that contain spectral data.

  See also

  CIE 1931 - xy calculations

- **y (10°)** - The CIE 1964 y coordinate using 10° observer data. This data is only available for measurements that contain spectral data.

  See also

  CIE 1931 - xy calculations

- **u** - The CIE 1960 u coordinate. This data is only available for measurements that contain tristimulus data.

  See also

  CIE 1960 - uv calculations

- **v** - The CIE 1960 v coordinate. This data is only available for measurements that contain tristimulus data.

  See also

  CIE 1960 - uv calculations

- **u'** - The CIE 1976 u' coordinate. This data is only available for measurements that contain tristimulus data.

  See also

  CIE 1976 - u'v' calculations

- **v'** - The CIE 1976 v' coordinate. This data is only available for measurements that contain tristimulus data.

  See also

  CIE 1976 - u'v' calculations

- **CCT** - The correlated color temperature (CCT) expressed in °Kelvin. This data is only available for measurements that contain tristimulus data.
- **MK-1** - The micro-reciprocal Kelvins. This data is only available for measurements that contain tristimulus data.
- **uv Deviation** - The deviation of the color temperature from the planckian locus. This data is only available for measurements that contain tristimulus data.
- **R** - The red component of the RGB space. This data is only available for measurements that contain tristimulus data.
- **G** - The green component of the RGB space. This data is only available for measurements that contain tristimulus data.
- **B** - The blue component of the RGB space. This data is only available for measurements that contain tristimulus data.
- **Dominant Wavelength (nm.)** - The dominant wavelength expressed in nanometers. This data is only available for measurements that contain tristimulus data.
- **Purity (%)** - The purity expressed as a percentage value. This data is only available for measurements that contain tristimulus data.
- **Sampling Period (µsecs)** - The sampling period of the temporal measurement expressed in µsecs. This data is only available for measurements that contain temporal data.

- **Sampling Rate (KHz.)** - The sampling rate of the temporal measurement in Kilo Hertz. This data is only available for measurements that contain temporal data.
- **Flicker Frequency (Hz.)** - The dominant flicker frequency calculated using FFT (Fast Fourier Transform) expressed in Hertz. This data is only available for measurements that contain flicker data.

  See also

  Flicker Frequency calculations

- **JEITA Flicker (Weighted Level) dB.** - The weighted flicker level to match the approximate temporal flicker sensitivity of the human eye expressed in decibels. This data is only available for measurements that contain flicker data.

  See also

  JEITA Flicker (JEITA (formerly EIAJ) flicker level, weighted level, ISO flicker) calculations

- **FMA Flicker (Modulation) %** - The photometric flicker calculation derived from the contrast. This data is only available for measurements that contain flicker data.

  See also

  Flicker Modulation Amplitude calculations

- **Percent Flicker (%)** - The photometric flicker calculation expressed as a percentage value. This data is only available for measurements that contain flicker data.

  See also

  Percent Flicker calculations

- **Flicker Index**. The photometric flicker calculation represented by an index. This data is only available for measurements that contain flicker data.

  See also

  Flicker Index calculations

- **L∗** - This data is only available for L∗a∗b∗ or L∗u∗v∗ measurements.
- **a∗** - This data is only available for L∗a∗b∗ measurements.
- **b∗** - This data is only available for L∗a∗b∗ measurements.
- **u∗** - This data is only available for L∗u∗v∗ measurements.
- **v∗** - This data is only available for L∗u∗v∗ measurements.
- **C∗ab (chroma)** - This data is only available for L∗a∗b∗ measurements.
- **h ab (hue)** - This data is only available for L∗a∗b∗ measurements.
- **C∗uv (chroma)** - This data is only available for L∗u∗v∗ measurements.
- **h uv (hue)** - This data is only available for L∗u∗v∗ measurements.
- **s uv (saturation)** - This data is only available for L∗u∗v∗ measurements.
- **△E∗ab** - This data is only available for L∗a∗b∗ measurements.
- **△H∗ab** - This data is only available for L∗a∗b∗ measurements.
- **△E∗uv** - This data is only available for L∗u∗v∗ measurements.
- **△H∗uv** - This data is only available for L∗u∗v∗ measurements.
- **Gamma (X)** - This data is only available for Gamma measurements.
- **Gamma (Y)** - This data is only available for Gamma measurements.
- **Gamma (Z)** - This data is only available for Gamma measurements.

Removing measurements

You can remove a single measurements or a group of measurements by selecting the columns indicating the measurements or fields on the data table. Clicking your right mouse button on the row header will display the menu to allow removal of the measurements. Since this is an irrecoverable operation a confirmation will be requested.

6.2.2 CIE View

The CIE view supports two sections, the CIE chart and the CIE data table.

The following actions are available

- **Toggle data table** - Toggles the CIE data view ON/OFF. The CIE data view allows you to highlight the measurements and acts as a legend for the CIE Chart.
- **CIE chart select** - Changes the CIE Chart displayed and plots the measurements in the corresponding chart. This also modifies the data visible in the Data table
  - CIE 1931 (xy)
  - CIE 1960 (uv)
  - CIE 1976 (u'v')
- **Toggle grid** - Toggles the grid displayed in the chart
- **Toggle color CIE** - Toggles the color CIE
- **Toggle labels** - Toggles all the labels and wavelength markers including the locus
- **Toggle gamut** - Toggles the display of the CIE gamut using the selected color profile
  - **Clear gamut** - Clears the CIE gamut for this chart.

6.2.2.1 CIE 1931 (xy)

CIE 1931 XYZ color spaces was one of the first mathematically defined color spaces by the International Commission on Illumination (CIE) in 1931 where the x, y coordinates are based on calculations using the 2° Standard Observer functions. The CIE 1931 x, y coordinates are used for the vast majority of color measurements.

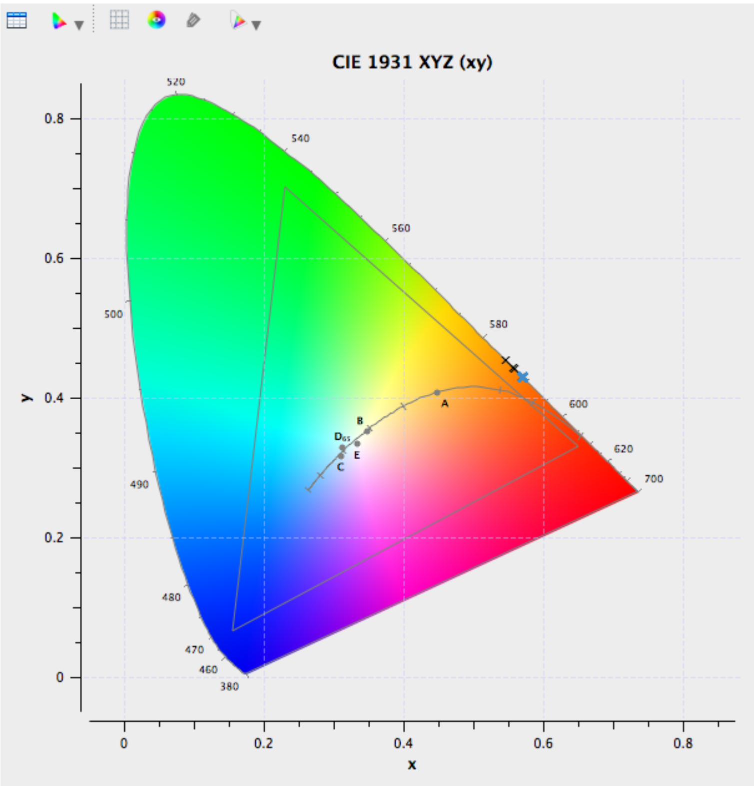

Figure 6.2 CIE 1931 View

See also

CIE 1931 - xy

6.2.2.2 CIE 1960 (uv)

The CIE 1960 color space also known as the CIE 1960 UCS (Uniform Color Space) is a modification of CIE 1931 (xy) Chromaticity Diagram, the CIE 1960 CIE Chromaticity Diagram is designed to present a more uniform color distribution of the CIE 1931 (xy) Chromaticity Diagram. Today, the CIE 1960 UCS is mostly used to calculate correlated color temperature, where the isothermal lines are perpendicular to the Planckian locus. As a uniform chromaticity space, it has been superseded by the CIE 1976 (u'v') UCS.

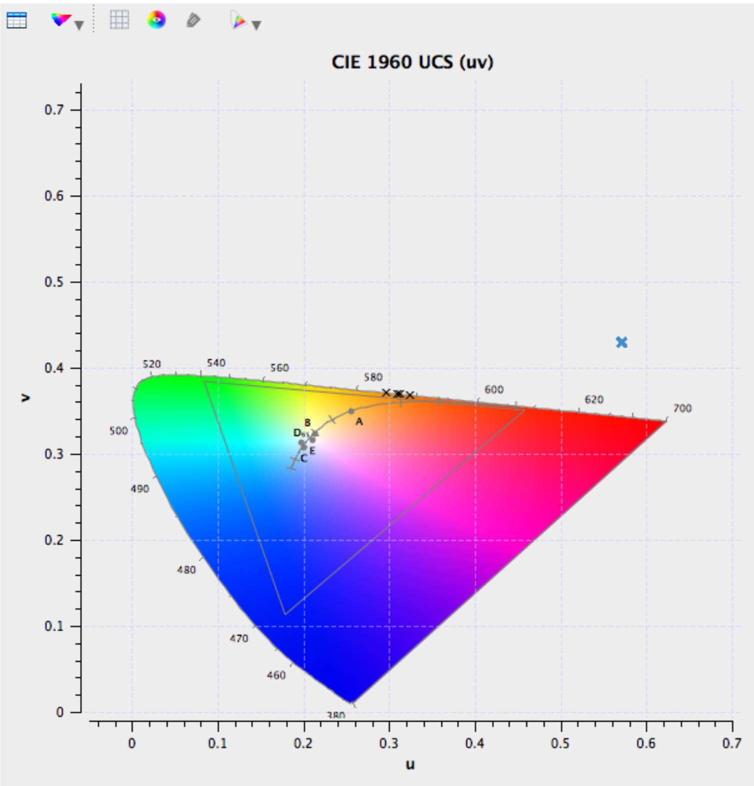

Figure 6.3 CIE 1960 View

See also

CIE 1960 - uv

6.2.2.3 CIE 1976 (u'v')

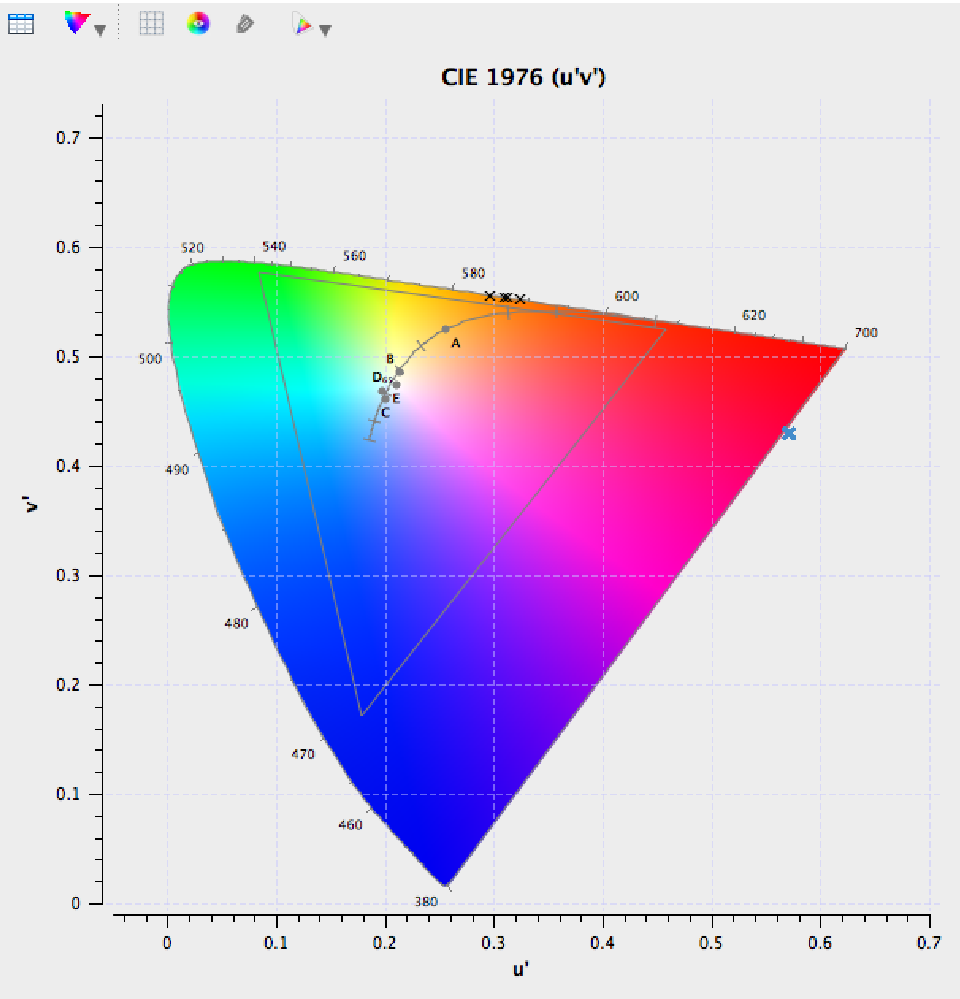

Figure 6.4 CIE 1976 View

CIE 1976 (L∗, u∗, v∗) color space, commonly known by its abbreviation CIELUV, is a color space adopted by the International Commission on Illumination (CIE) in 1976, as a simple-to-compute transformation of the CIE 1931 (xy) color space. It is an update version of the CIE 1960 (uv) color space. It is also known as the CIE 1976 UCS (Uniform Color Space), because it attempts to present perceptual color uniformity.

See also

CIE 1976 - u'v'

6.2.2.4 CIE 1964 (x10,y10)

A more modern but less-used alternative to the 2° observer based CIE 1931 (xy) is the CIE 1964 10° standard observer. For the 10° experiments, the observers were instructed to ignore the central 2° spot. The 1964 Supplementary Standard Observer function is recommended when dealing with more than about a 4° field of view.

Note

In this view, the display of the color gamut and the color CIE is disabled.

6.2.3 Spectrum View

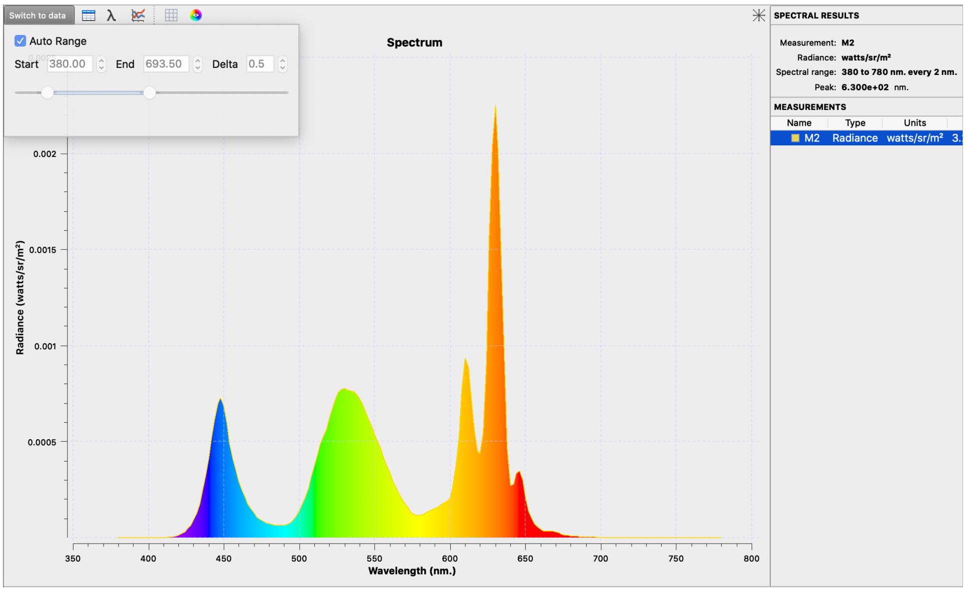

Figure 6.5 Spectrum View - Graphical

The spectrum view can be used to visualize spectral data in a graphical or a tabular form. In the spectrum view, each spectra can be displayed in their native resolution or the spectra can be interpolated to the specified spectral range.

Note

If interpolated the views, calculations and the results are displayed only for the specified spectral range. The spectral range used is clearly indicated below the title of the Spectrum data view.

- The following is the list of actions available for the spectrum view.
  - **Switch to Data** - Switches the view to tabular visualization.
  - **Switch to Chart** - Switches the view to graphical visualization.
  - **Toggle measurement list** - Displays the measurement list.
  - **Adjust spectral range** - Adjusts the spectral range in focus.
    - **Auto range** - Uses the native spectral range of each measurement, if disabled the spectrum is interpolated using the start, end and delta settings selected below
    - **Start** - Starting wavelength of the required spectral range
    - **End** - Ending wavelength of the required spectral range
    - **Delta** - Wavelength delta (increments)
  - **Toggle mode** - Toggles the measurement display mode. This is only available for the graphical visualization.
    - **Single measurement mode** - Displays only the spectrum of the selected measurement from the measurement list. This will always default to the last measurement added to the view.
    - **Multiple measurement mode** - Displays the spectral graphs of all the measurements.
  - **Toggle grid** - Toggles the grid.
  - **Toggle color spectrum** - Toggles the color spectrum.

Note

In the multiple measurement mode the color spectrum is visible if only one measurement is present.

– **Customize axis**. Customizes the axis of the chart. This is only available for the graphical visualization.

  * **Normalize to** - Normalizes the spectra to the level specified.
  * **Logarithm** - Displays the radiometric data in log.

- The spectrum view also displays the following results and calculations.

  – **Results** - Adjusts the spectral range in focus

    * **Measurement Name** - Name of the selected measurement
    * **Spectral Range** - Spectral range
    * **Peak** - Peak wavelength of the selected spectrum

Figure 6.6 Spectrum View - Tabular

6.2.4 Trend View

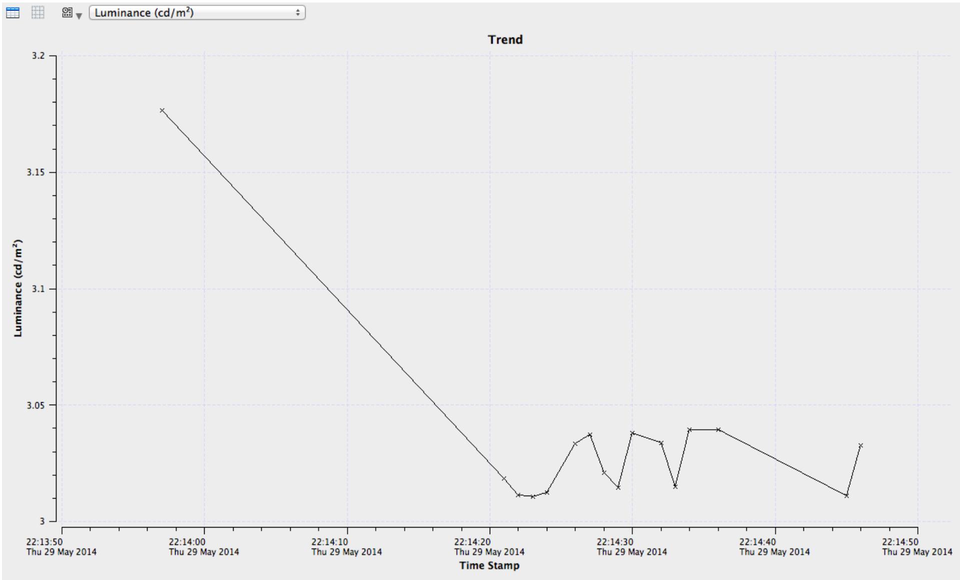

Figure 6.7 Trend View

The trend view can be used to visualize the trend of photometric data in a graphical form.

- The following is the list of actions available for the trend view.
  - **Toggle measurement list** - Displays the measurement list.
  - **Toggle grid** - Toggles the grid.
  - **X-Axis** - Switches the parameters on the x-axis.
    - **Sequence** - The trend points are plotted sequentially.
    - **Date/Time** - The trend points are plotted on a date & time scale using the measurement timestamp.
  - **Y-Axis** - Switches the parameters on the y-axis.
    - **X** - Tristimulus X.
    - **Y** - Tristimulus Y.
    - **Z** - Tristimulus Z.
    - **Luminance (cd/m^2 = nits)** - Luminance expressed in cd/m^2 or nits.
    - **Luminance (fL)** - Luminance expressed in footLamberts.
    - **Illuminance (lux)** - Illuminance expressed in lux.
    - **Illuminance (fc)** - Illuminance expressed in footcandles.
    - **Luminous Intensity (candelas)** - Luminous Intensity expressed in candelas.
    - **Luminous Intensity (millicandelas)** - Luminous Intensity expressed in millicandelas.
    - **Luminous Flux (lumens)** - Luminous Flux expressed in lumens.
    - **Luminous Flux$<$ (candelas** - Luminous Flux expressed in candelas.
    - **CCT** - Correlated Color Temperature in °Kelvin.

6.2.5 L∗a∗b∗ View

The L∗a∗b view can be used to visualize the LAB data in a graphical form.

6.2.6 CRI View

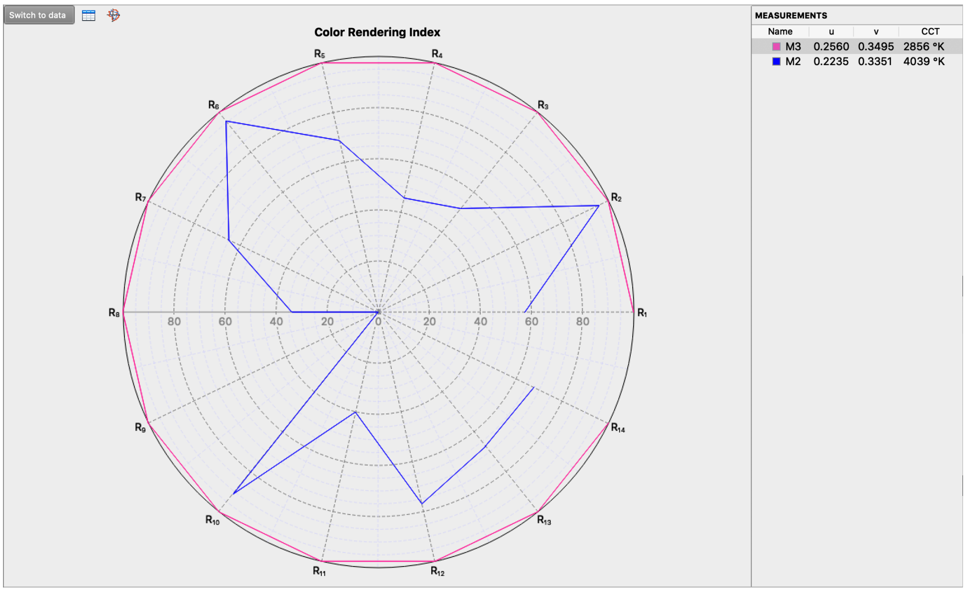

Figure 6.8 CRI View - Graphical

The color rendering of a light source is the effect the source has on the appearance of objects in comparison with their appearance under a reference source. The Color Rendering Index (CRI) of a light source is a measure of the degree to which the perceived colors of objects illuminated by the source conform to those of the same objects illuminated by a standard source, for specified conditions. The usual conditions are that the observer shall have normal color vision and be adapted to the environment illuminated by each source in turn.

Numerically, the highest possible CRI is 100, for a Black body (incandescent lamps are effectively blackbodies), dropping to negative values for some light sources.

The first eight samples are relatively low saturated colors and are evenly distributed over the complete range of hues. These eight samples are employed to calculate the general color rendering index $\mathbf{R_a}$. The last six samples provide supplementary information about the color rendering properties of the light source; the first four for high saturation, and the last two as representatives of well-known objects.

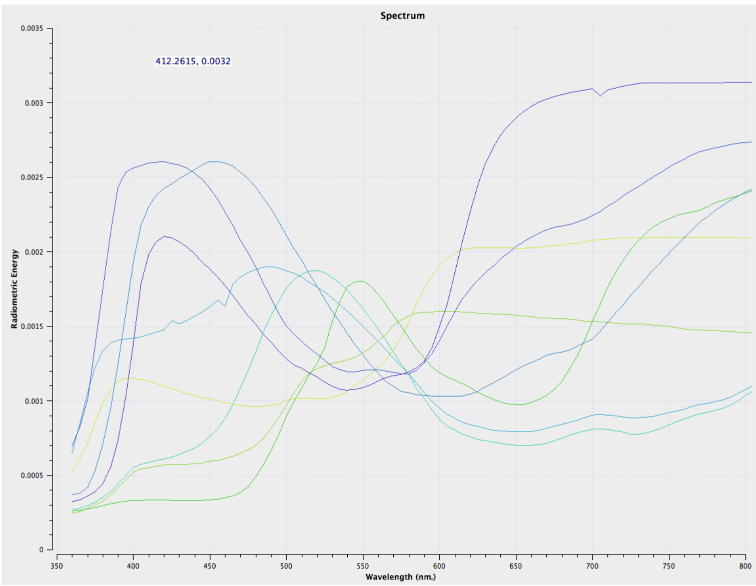

Figure 6.9 CRI Test Samples Spectral Power Distribution

The CRI view can be used to visualize CRI data in a graphical polar chart or a tabular form.

- The following is the list of actions available for the CRI view.
  – **Switch to Data** - Switches the view to tabular visualization
  – **Switch to Chart** - Switches the view to graphical visualization
  – **Toggle measurement list** - Displays the measurement list
  – **Toggle mode** - Toggles the measurement display mode. This is only available for the graphical visualization.
    * **Single measurement mode** - Displays only the CRI indices of the selected measurement from the measurement list. This will always default to the last measurement added to the view.
    * **Multiple measurement mode** - Displays the CRI indices in the polar graph for all the measurements.

The Color Rendering Index is calculated by default using an auto created spectrum based on the Correlated Color Temperature of the measurement sample. See Color Rendering Index Workspace Property to modify the reference measurement used for calculation.

Note

The reference used is clearly indicated below the title of the CRI data view.

	M3	M2
R_1	100	57
R_2	100	96
R_3	100	52
R_4	100	46
R_5	100	69
R_6	100	96
R_7	100	65
R_8	100	34
R_9	100	-24
R_{10}	100	91
R_{11}	100	40
R_{12}	100	77
R_{13}	100	67
R_{14}	100	68
R_a	100	64

Name	u	v	CCT
M3	0.2560	0.3495	2856 °K
M2	0.2235	0.3351	4039 °K

Figure 6.10 CRI View - Tabular

6.2.7 Gamma View

The Gamma view can be used to visualize gamma measurement data in a graphical chart.

- The following is the list of actions available for the Gamma view.
  – **Toggle measurement list** - Displays the measurement list
  – **Toggle color** - Switches the chart between gray scale and color scale visualization
  – **Toggle mode** - Toggles the measurement display mode.
    * **Single measurement mode** - Displays only the values of the selected measurement from the measurement list. This will always default to the last measurement added to the view.
    * **Multiple measurement mode** - Displays the values for all the measurements.
  – **Toggle normalization** - Switches the normalization of the data ON or OFF

6.2.8 Flicker View

The Flicker View is used to analyze the flicker characteristics of the temporal signal. This can be done both in the time domain and the frequency domain.

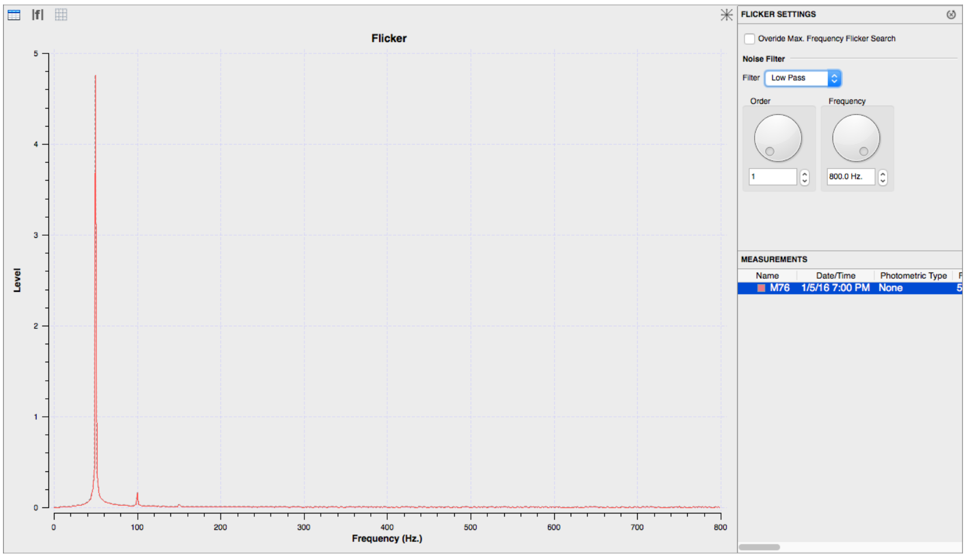

Figure 6.11 Flicker View

- The following is the list of actions available for the flicker view.
  - **Toggle measurement list** - Displays the measurement list
  - **Toggle domain** - Toggles the temporal domain between time and frequency.
    - **Time domain**
    - **Frequency domain**
  - **Toggle grid**
  - **Customize axis**

Flicker Settings

- **Reset to default** - .
- **Override Max. Frequency Flicker Search** - This parameter is used to override the maximum flicker search frequency specified in the instrument setup.
- **Filter** - The acquired temporal signal may contain a significant amount of noise. The filter selection to smooth out the noise of the signal.
  - **None** - No filter is applied.
  - **Low Pass** - A ripple filter using a tuned moving average filter, with a variable window average.
  - **High Pass** - A ripple filter using a tuned moving average filter, with a variable window average.
  - **Band Pass** - A ripple filter using a tuned moving average filter, with a variable window average.
  - **Band Stop** - A ripple filter using a tuned moving average filter, with a variable window average.
- **Order Selection** - Select the order of the noise filter.
- **Frequency Selection** - Select the cutoff frequency of the noise filter.
- **Bandwidth Selection** - Select the bandwidth of the band pass and band stop filters.

Note

There are two signals shown in the graph. The original temporal response is grayed out and made slightly transparent and is used a reference. All calculations are made on the filtered (color coded) response. When a filter is applied to the data you will notice a change in the filtered response based on the averaging window used. Adjust the filter parameters to filter out the undesirable noise. The flicker parameters will be updated dynamically.

- Time Domain Time domain is the analysis of temporal data, with respect to time. A time-domain graph shows how a signal changes with time.

The time domain y-axis has three options to

- **Auto** - The scale auto adjusts to all display all the data
- **Normalized** - The scale is normalized to a scale from 0-100%
- **Custom** - The scale adjusts to a user entered fixed scale.

Indicators In the time domain the graph displays the minimum(red), maximum(green) and average(blue) horizontal dotted indicators. These indicators are not displayed when the multiple measurement mode is selected.

- Frequency Domain Frequency domain is the analysis of temporal data, with respect to frequency. Frequency-domain graph shows how much of the signal lies within each given frequency band over a range of frequencies.

6.2.9 Response Time View

The Response Time View is used to analyze the response time of the temporal signal.

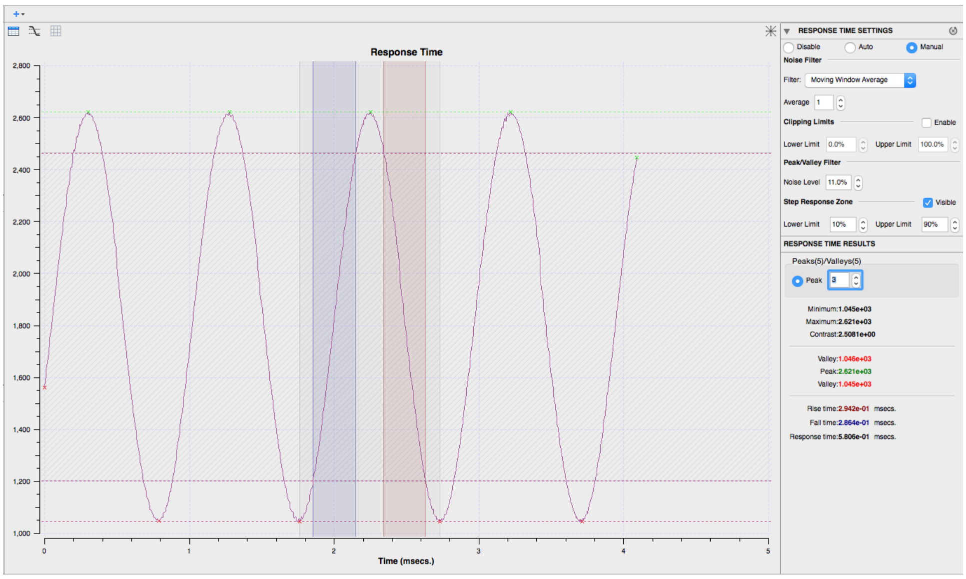

Figure 6.12 Response Time View

- The following is the list of actions available for the response time view.

  – **Toggle measurements list** - The measurement list allows selecting of the measurements displayed in the view
  – **Adjust step response range** - Toggles the display and modifies the low and the high end of the step response

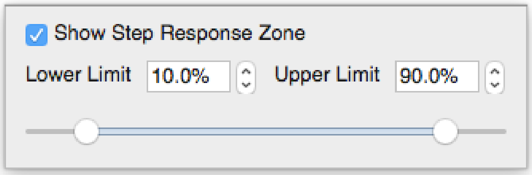

Figure 6.13 Adjust Step Response Range

  – **Toggle grid** - Toggles the grid displayed in the response time chart.

Response time settings

- **Response time mode**
  – **Disable** - Response time analysis is not performed or displayed on the graph.
  – **Auto** - Automatically perform response time analysis.
  – **Manual** - Complete manual response time analysis for finer control of noisier signals.

- **Noise Filter** - The acquired temporal signal may contain a significant amount of noise. The filter selection to smooth out the noise of the signal.
  – **None** - No filter is applied.
  – **Moving Window Average** - A ripple filter using a tuned moving average filter, with a variable window average.

Note

This affects the rise time and the fall time calculations

- **Average** - The number of points to average used in the Moving Window Average Noise Filter

- **Clipping Limits** - This parameter is to eliminate the noisy peaks which fall within this level
  – **Enable** - Enables clipping of the signal.
  – **Lower Limit (%)** - Percentage of the lower level signal to clip.
  – **Upper Limit (%)** - Percentage of the upper level signal to clip.

- **Peak/Valley Filter (%)** - This parameter is to eliminate the noisy peaks which fall within this level

- **Step Response Zone** -
  – **Visible** - Displays the step response zone to calculate the rise and fall time. The default values are 10-90%. Values of 0-100% or 5-95% are also commonly used.
  – **Lower Limit (%)** - The step response lower limit.
  – **Upper Limit (%)** - The step response upper limit.

- **Peak Selection** - Select the peak to analyze the response times.

Response time results

- **Minimum** - Minimum value of the cycle.
- **Maximum** - Maximum value of the cycle.
- **Contrast** - Contrast of the cycle

$$Contrast = \frac{Maximum}{Minimum}$$

- **Valley** - The two valleys on either side of the peak which is used to calculate rise and fall times.
- **Peak** - The peak for which the rise and fall times are calculated.
- **Rise time** (T_{on}) - The rise time is the time that it takes for the signal to transition from 10% (T_{10}) to 90% (T_{90}) of the initial and ending relative levels.

$$T_{on} = T_{off-to-on} = T_{90} - T_{10}$$

Note

This value is corrected based on the filter used. In the graph a blue shaded zone is used to indicate the rise time.

- **Fall time** (T_{off}) - The fall time is the time that it takes for the signal to transition from 90% (T_{90}) to 10% (T_{10}) of the initial and ending relative levels.

$$T_{off} = T_{on-to-off} = T_{10} - T_{90}$$

This value is corrected based on the filter used. In the graph a red shaded zone is used to indicate the fall time.

- **Response time** - Corrected response time based on the filter used. Here the response time is the sum of the rise and the fall times. If either of the valleys are not available, the response time is not reported.

$$Response\ Time = T_{off} + T_{on}$$

Note

If a peak is selected, the Minimum, Maximum, and the Contrast parameters are within the selected cycle, otherwise they are for the entire temporal signal.

6.2.9.1 Understanding the Response Time View

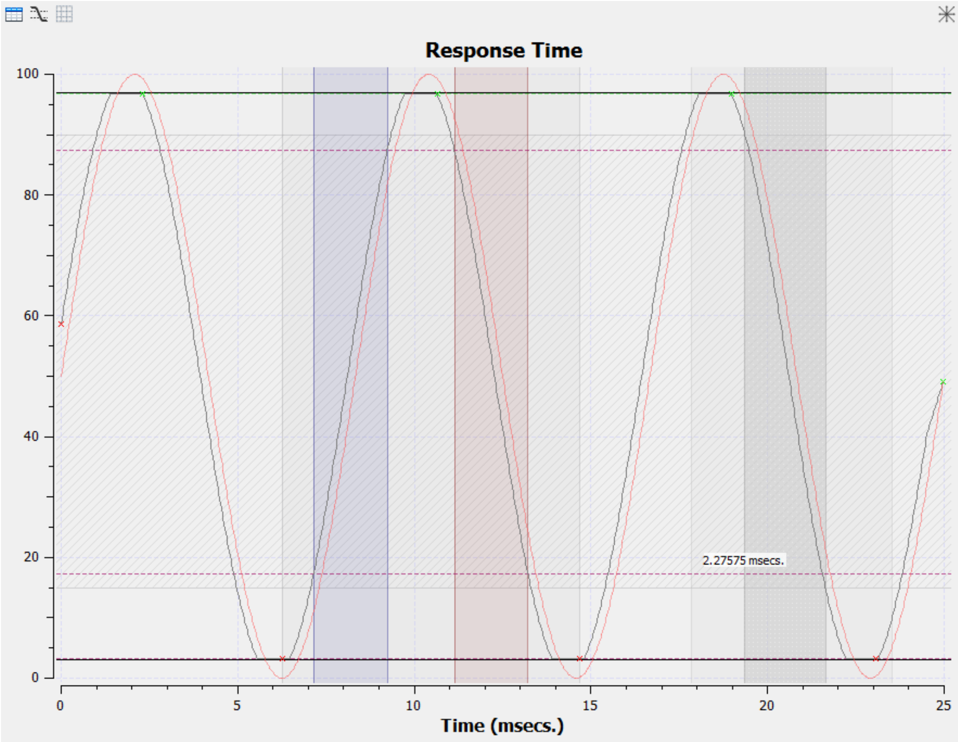

Figure 6.14 Understanding the Response Time View

- Original response time signal
- Filtered response time signal
- Peak markers
- Valley markers
- Rise time zone
- Fall time zone
- Response time calculation cycle
- Step response zone
- Clipping zone
- Quick selection zone
- Quick selection response time zone and value

There are two signals shown in the graph. The original temporal response (color coded) is made slightly transparent and is used a reference. All calculations are made on the filtered (dark gray) response. When a filter is applied to the data you will notice a change in the filtered response based on the averaging window used. Adjust the filter parameter to get a clean filtered signal. Then adjust the noise level to filter out the noisy peaks and valleys. A correction factor will be applied to the rise and fall times to compensate for the degradation of the signal due to the filter.

6.2.9.2 Quick Calculation Tool

6.3 Copy, Export & Logging

The CRI App allows you to easily copy and export all graphs and data into your own spreadsheet application for further analysis and custom report generation.

6.3.1 Export

The export action allows you to export data based on the current view. The formats supported are

- **Comma Separated Values (CSV)** - Each row of fields are separated by commas terminated with a new line character. This is suitable for exporting into spreadsheet applications such as `Microsoft Excel`, `Apple Numbers` and `OpenOffice Calc`, etc.
- **Tab Separated Text (TXT)** - Each row of fields are separated by tabs terminated with a new line character.

6.3.2 Copy

While the Export feature allows you to export all the data, the copy features allows you to copy *all* or just the *selected* data. Along with the data the copy function allows you to copy the image of the visible graphs in the view.

6.3.3 Export Data View

All data can be exported using the export action. Individual cells can be copied by using the Copy shortcut key combination.

Note

The copy short cut key is Ctrl+C for windows and Command+C for OS X.

6.3.4 Data Log

Data logging allows logging measurements to a file or output selected values to a DAC Channel.

Note

When large amounts of measurements are to be logged, it is advisable to display only a selected number of measurements in the workspace. This can be done by replacing (n) measurements in the Data View

See also

datalog_inspector

6.4 Inspectors

6.4.1 Workspace Property Inspector

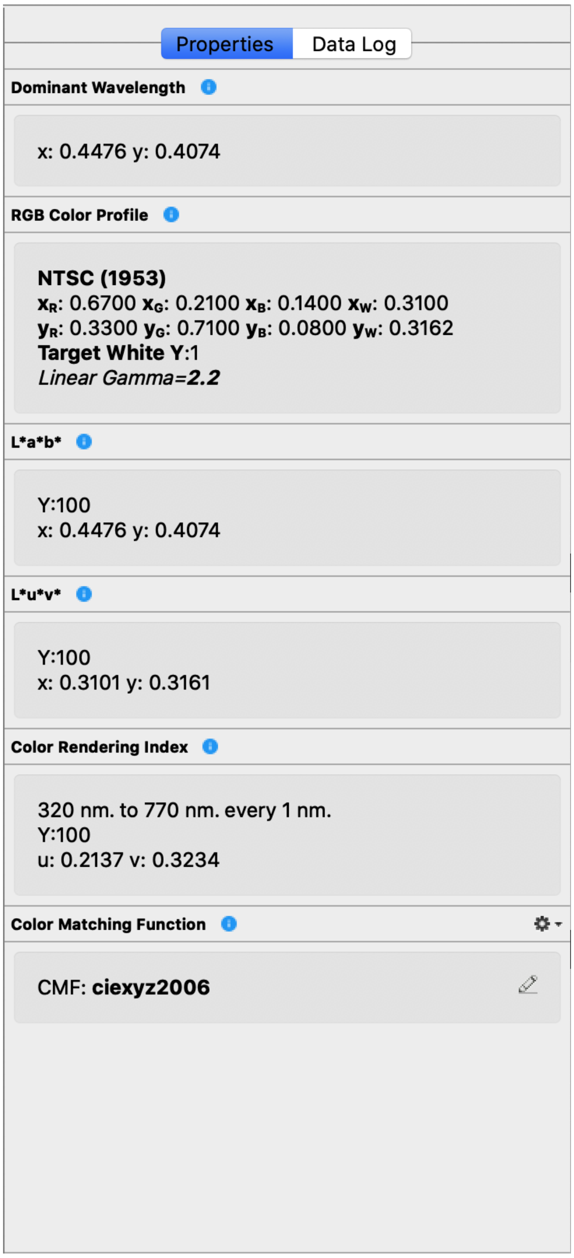

Figure 6.15 Properties

The workspace properties provide settings for the workspace. Each section is a drop zone that allows dragging of References or Color Profiles used in the respective calculations. If a property is set, moving the mouse over the drop zone displays an icon to clear the property. This can be also achieved by clicking Clear form the context menu obtained by pressing the right mouse button over the drop zone.

6.4.1.1 Dominant Wavelength

The dominant wavelength reference measurement.

6.4.1.2 RGB Color Profile

The color profile used for RGB calculations.

6.4.1.3 $L{*}a{*}b$

The reference measurement used to compute $\Delta E{*}ab$ and $\Delta H{*}ab$.

6.4.1.4 $L{*}u{*}v{*}$

The reference measurement used to compute $\Delta E{*}uv$ and $\Delta H{*}uv$.

6.4.1.5 Color Rendering Index

The reference measurement used to compute the Color Rendering Index. If none is selected, an reference is automatically created using a black body or a day light simulation based on the color temperature of the measurement sample.

6.4.2 Data Log Inspector

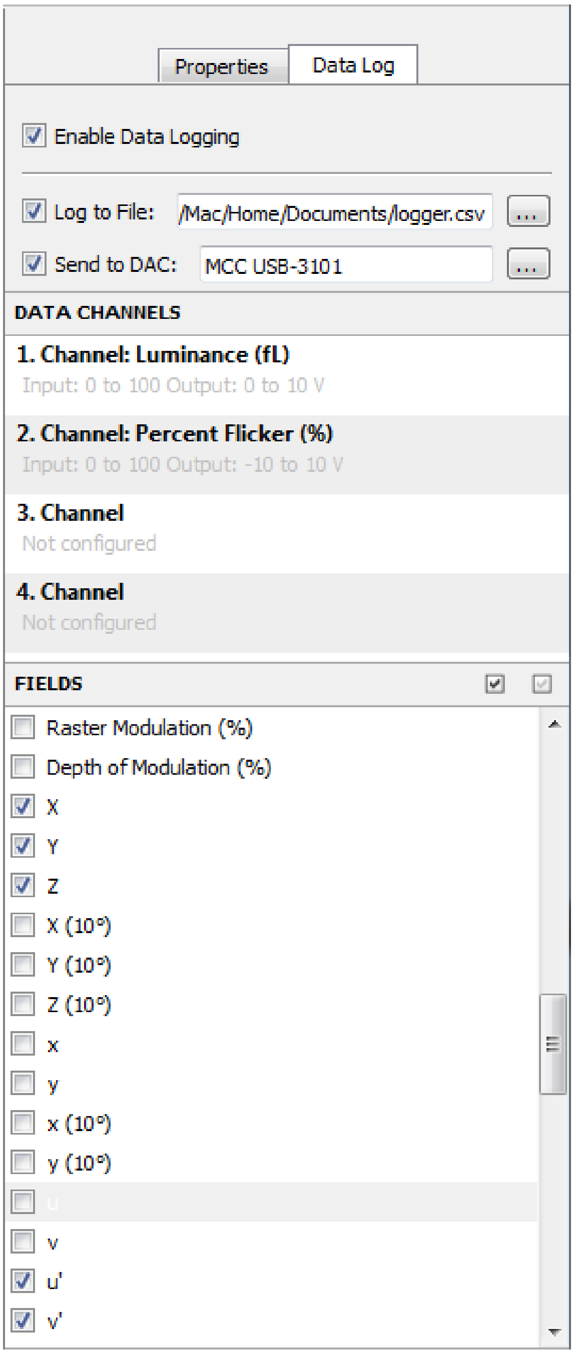

Figure 6.16 Data Log

6.4.2.1 Settings

- **Enable Data Logging** - All data logging is enabled or disabled.

This is indicated by this field and also represented by the Data Log icon in the main toolbar.

- **Log to File** - Logging to file is enabled or disabled. The text shows the file name or displays a placeholder text indicating a file is not selected.

The selected Fields are appended to a file. Whenever the fields are modified or the first time a measurement is logged, a new header is appended with a leading **##** header marker.

- **Send to DAC** - Output to a DAC is enabled or disabled. The text shows the identifier of the selected DAC or displays a placeholder text indicating none selected.

Whenever a DAC is selected Data Channels will display the settings for each of the available DAC channels.

6.4.2.2 Data Channels

The available channels are listed.

Each channel displays the following information

- Index - Channel index
- Field - The channel index is followed by the field name if it is configured
- Channel settings - Displays the input/output and units configured for the channel. Otherwise "Not configured" will be displayed.

Double clicking your mouse on the Channel brings you to the Channel Settings.

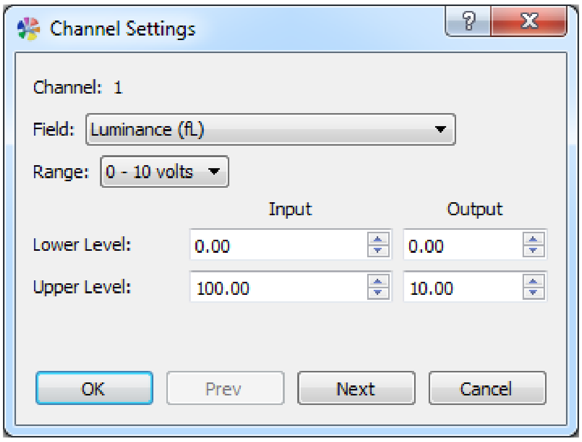

Figure 6.17 DAC Channel

- **Channel** - Displays the channels settings for the displayed channel number
- **Field** - Lists all the numeric fields that can be output to the channel
- **Range** - The different ranges supported by the DAC for this channel
- **Units scaling** - The lower and upper levels of the input are scaled to the lower and upper levels of the output. The output levels have to be within the selected range.
- **Next**/**Prev** - Jumps to the previous or next channel settings.

6.4.2.3 Fields

All the all the available measurement fields that can be logged to a file, select only the ones that are required. These fields could be numeric or text.

The selection of the data log fields are independent of the measurement field selection in the Data View

Chapter 7

Measurements

7.1 Measurements Panel

Each measurement mode displays placeholders for readings which are required to complete a measurement. The current placeholder is highlighted in a shade of purple. If you want to change the placeholder for the next reading, select the placeholder and the current position will be changed. When a measurement is filled into a placeholder by a Capture, the next placeholder gets highlighted. If all the placeholders are filled the measurement gets dispatched to the Workspace.

The measurement placeholders also support drag and drop. You can drag readings from one placeholder to another or drag it into the drop zones that accept measurements such as References or Workspace Property Inspector. You can also drag measurements into the placeholder from References.

Note

Standard mode does not display this panel.

Readings are saved across application sessions.

The following actions are available

- **Dispatch measurement** - This action manually dispatches the measurement calculated from the readings in the placeholders into the Workspace. Measurements are automatically dispatched after capture provided all placeholders are full.

  Note

  The dispatch icon in the action toolbar is enabled when all the placeholders contain readings.

- **Clear measurements** - This action clears all the readings in the placeholders and the current measurement indicator gets reset to the first placeholder.

  Note

  If any of the placeholders contain a reading, clear measurements option menu clears all readings.

7.2 Measurement Modes

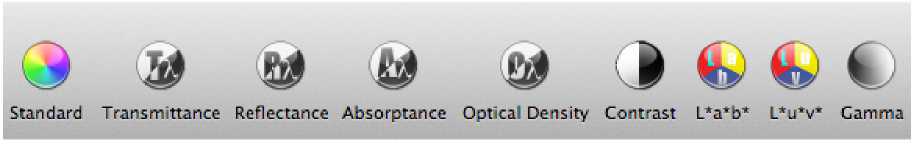

Figure 7.1 Measurement modes

The measurement modes currently supported by CRI App are

- Standard
- Transmittance
- Reflectance
- Absorptance
- Optical Density
- Contrast
- L∗a∗b∗
- L∗u∗v∗
- Gamma

7.2.1 Standard

This mode takes a single basic measurement which depends on the setup of the instrument.

Standard measurements are those made of directly from the instrument without the need to perform any mathematical operation to remove any ambient or other light source or to obtain the final calculated values. These include standard tristimulus or photometry measurements and temporal measurements such as flicker.

7.2.2 Transmittance

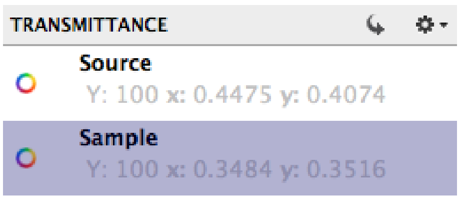

Figure 7.2 Transmittance Settings

Transmittance is the fraction of incident light at a specified wavelength that passes through a sample.

Transmittance measurements require two measurements to provide the final result.

- **Source** - An illuminating light source.
- **Sample** - A combination of the light source and sample.

See also

Transmittance calculations

7.2.3 Reflectance

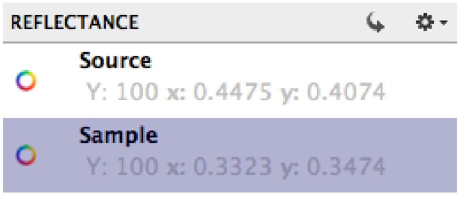

Figure 7.3 Reflectance Settings

Reflectance is the fraction of incident light that is reflected at an interface.

A reflectance measurement is a sequence of two measurements.

- **Source** - A light source illuminating a reflective sample
- **Sample** - The light source and sample together.

See also

Reflectance calculations

7.2.4 Absorptance

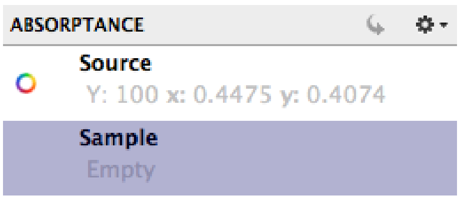

Figure 7.4 Absorptance Settings

An absorptance measurement is the inverse of transmittance or reflectance. It is the measurement of the light that is not allowed to reflect from or transmit through the sample under test.

- **Source** - The light source.
- **Sample** - The light source and sample together.

7.2.5 Optical Density

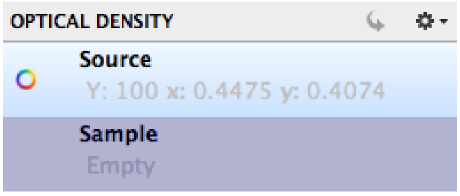

Figure 7.5 Optical Density Settings

Optical density (also called absorbance) of a material is a logarithmic ratio of the light falling upon a material, to the light transmitted through a material.

Optical density is a value derived from a transmittance measurement. It is a measurement of the density (attenuation) of the sample under test. It is a term typically used by filter manufacturers. For example neutral density filters refer to a filter that is spectrally flat (neutral) with a specific density.

- **Source** - The light source.
- **Sample** - The light source and sample together.

See also

Optical Density calculations

7.2.6 Contrast

The contrast ratio is a property of a display system, defined as the ratio of the luminance of the brightest color (white) to that of the darkest color (black) that the system is capable of producing.

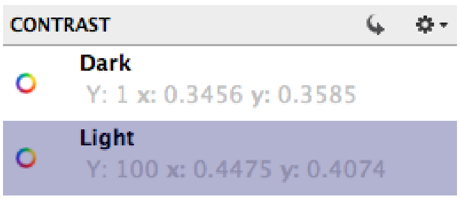

Figure 7.6 Contrast Settings

- **Dark** - A measurement when the sample is dark.
- **Light** - A measurement when the sample is bright.

7.2.7 L∗a∗b∗

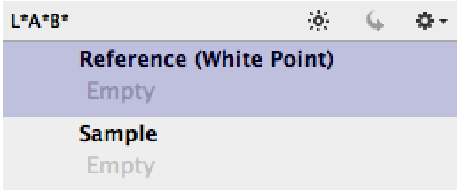

Figure 7.7 L∗a∗b∗ Settings

L∗a∗b∗ measurements are usually made of transmissive or reflective sources. Therefore, they typically require an external illuminating light source that must be mathematically removed. In this way, it is similar to a reflectance or transmittance measurement in that it requires two measurements to complete the sequence. If the sample for L∗a∗b∗ measurements does require an external light source, make sure Illuminated sample is chosen.

- **Reference (White Point)** - A reference measurement or an illuminant
- **Sample** - A measurement sample

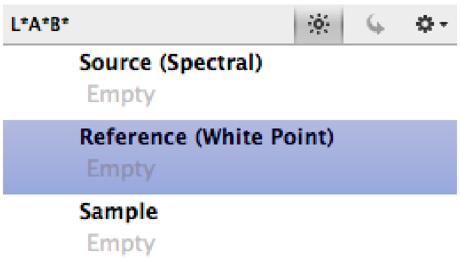

Figure 7.8 L∗a∗b∗ Settings - Illuminated using an external source

- **Source (Spectral)** - A source measurement or an illuminant
- **Reference (White Point)** - A reference measurement or an illuminant
- **Sample** - A measurement sample

7.2.8 L∗u∗v∗

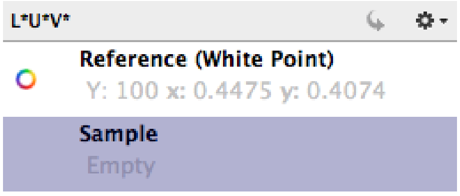

Figure 7.9 L∗u∗v∗ Settings

L∗u∗v∗ measurements are usually made of self-emitting samples (e.g., LCD's) and therefore do not require an external light source.

- **Reference (White Point)** - A reference measurement or an illuminant
- **Sample** - A measurement sample

7.2.9 Gamma

Gamma measurements are used to characterize the gray scale or color scale of displays. Any number of measurements between 2 and 25 can be used to characterize the gamma. Information Display Measurements Standard (IDMS) recommend 9 or 17 levels of grayscale measurements.

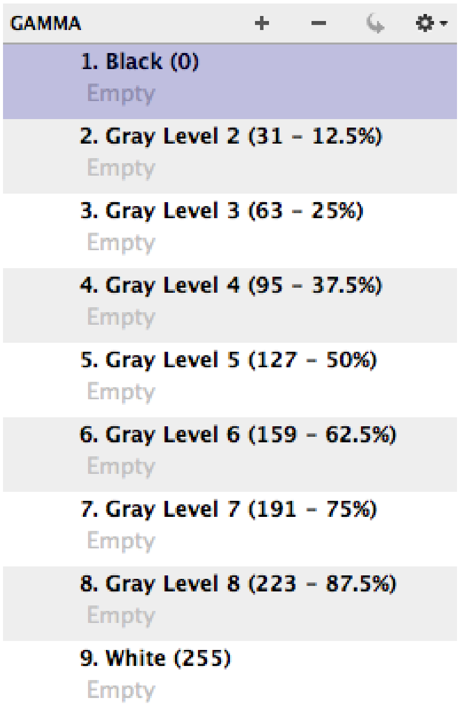

Figure 7.10 Gamma Settings

- **Increase** - Increase the number of gray levels
- **Decrease** - Decrease the number of gray levels

Chapter 8

References

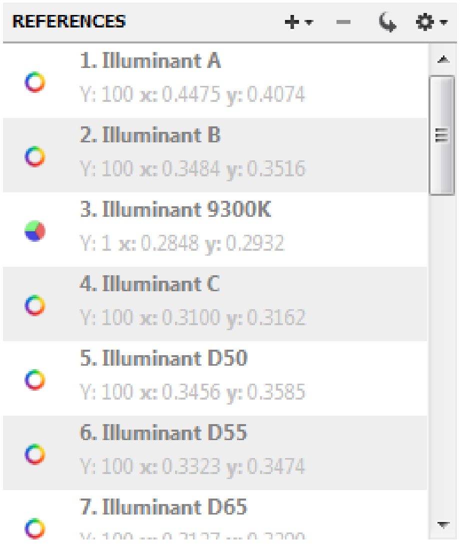

Figure 8.1 References

References consists of Standard Illuminants which white light sources used in calculating such color parameters as CIE L∗a∗b∗ and L∗u∗v∗ and custom measurement references that are saved from measurements or manually created.

- The reference pane actions
  - **Add photopic**
  - **Add tristimulus**
  - **Remove reference**
  - **Dispatch measurement**
  - **Options**
    - **View factory references**
    - **CIE xy**
    - **CIE uv**
    - **CIE u'v'**
    - **XYZ**

They are used to mathematically predict the color of particular stimuli under the affect of the illuminant. For example, for L∗a∗b∗ measurements of reflective or transmissive sources, the light used to illuminate the material for the measurement is mathematically removed and replaced with the Standard Illuminant spectrum prior to calculating color and ultimately L∗a∗b∗ values.

Note

> The reference pane can be toggled on or off using the reference pane 'RGB triangle' icon in the status bar.

A standard illuminant is a theoretical source of visible light with a profile (its spectral power distribution) which is published. Standard illuminants provide a basis for comparing measurements or colors recorded under different lighting.

- **Illuminant A**

The CIE defines Illuminant A in these terms: CIE standard Illuminant A is intended to represent typical, domestic, tungsten-filament lighting. Its relative spectral power distribution is that of a Planckian radiator at a temperature of approximately 2856 K. CIE standard illuminant A should be used in all applications of colorimetry involving the use of incandescent lighting, unless there are specific reasons for using a different illuminant.

- **Illuminants B and C**

Illuminants B and C are daylight simulators. They are derived from Illuminant A by using a liquid filters. B served as a representative of noon sunlight, with a correlated color temperature (CCT) of 4874 K, while C represented average day light with a CCT of 6774 K. They are poor approximations of any common light source and deprecated in favor of the D series:[1]

- **Illuminant series D**

D series of illuminants are constructed to represent natural daylight. They are difficult to produce artificially, but are easy to characterize mathematically.

- **Illuminant E**

Illuminant E is an equal-energy radiator; it has a constant Spectral Power Distribution inside the visible spectrum.

- **Illuminant series F**

The F series of illuminants represent various types of fluorescent lighting.

- FL 1–6: Standard
- FL 7–9: Broadband
- FL 10–12: Narrowband

- **CIE**

The CIE series of illuminants represents the CIE tristimulus.

- X, Y & Z - 2° observer
- X, Y & Z - 10° observer

Note

> Based on the display preferences, the references pane displays the Yxy, Yuv, Yu'v' or XYZ if it's a tristimulus or spectral reference and Y if it's a photometric reference. The icon also indicates whether it's a photopic, tristimulus or a spectral measurement.

8.1 Add/Remove References

In the pane actions, '+' icon allows you to add custom references to the references collection. You can also drag photometric, tristimulus or spectral measurements from the measurement mode settings.

See also

Measurements

Note

The stock (factory) references cannot be removed and are showed as slightly grayed out.

Chapter 9

Color Profiles

Within the context of the CRI App, a color profile is a combination of a color gamut and a white point.

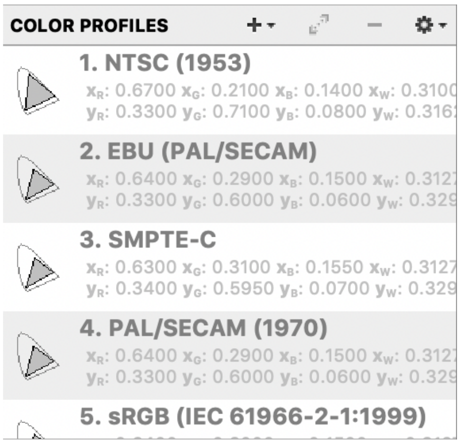

Figure 9.1 Color Profiles

- The following is a list of actions available for the color profile pane
  - **Add color profile** - Adds a new color profile
  - **Remove color profile** - Removes the selected color profile
  - **Options** - More options
    - **View factory color profiles** - Toggles the visibility of factory profiles in the list

The color profile pane displays the list of all color profiles available for use within the application. Each color profile is displayed as its CIE 1931 xy values for each of its RGB and white points. The icon depicts the Gamut in the CIE 1931 coordinate system for a quick representation.

Color profiles are used to calculate RGB. They are also used to display color gamuts in the CIE Charts CIE View. The color profiles are draggable items. They can be dragged on to the CIE View charts or into the RGB Color Profile property.

Note

The color profile pane can be toggled on or off using the color profile pane 'Light bulb' icon in the status bar.

9.1 Add/Remove Color Profiles

In the pane actions, '+' icon allows you to add custom color profiles to the color profiles collection.

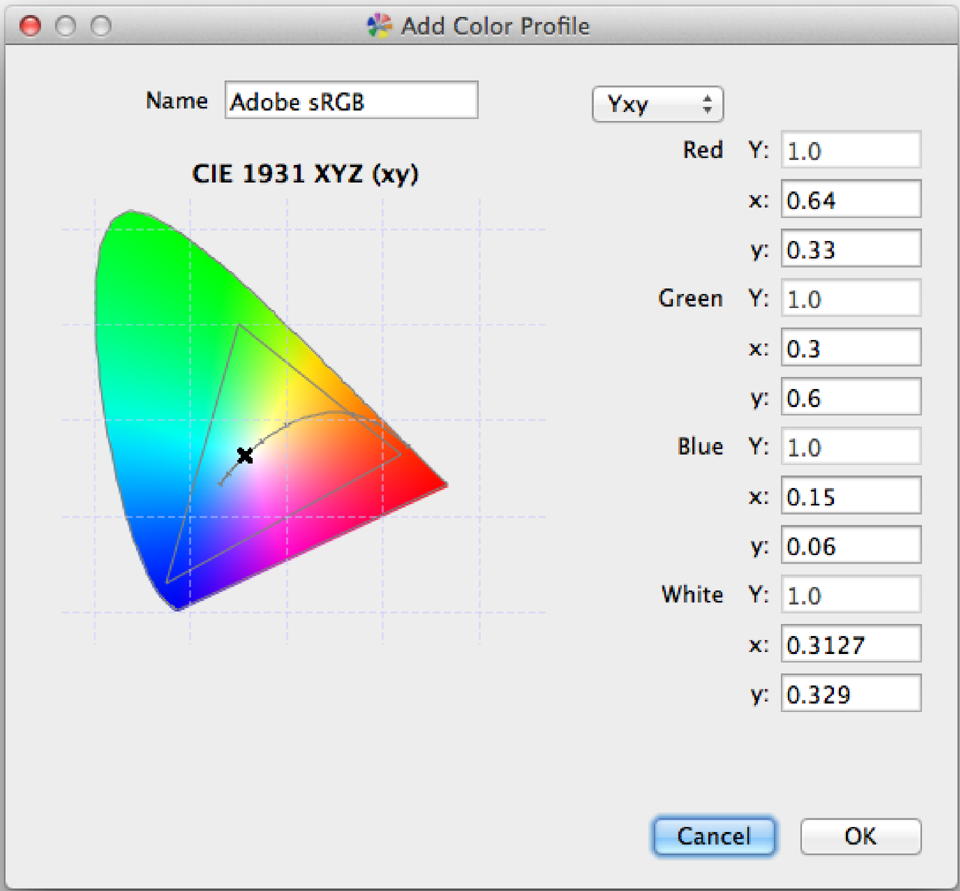

Figure 9.2 Color Profiles

- **Name** - A unique name that will be used to identify the color profile in the list.
- **Data type** - Switches the input data type for the gamut and the white point. This also display the corresponding CIE chart
  - **XYZ** - XYZ Tristimulus
  - **Yxy** - Y and the CIE 1931 x,y parameters
  - **Yuv** - Y and the CIE 1960 u,v parameters
  - **Yu'v'** - Y and CIE 1976 u',v' parameters
- **Red** - The red coordinate of the color gamut
- **Green** - The green coordinate of the color gamut
- **Blue** - The blue coordinate of the color gamut
- **White** - The coordinates of the white point

Note

Once all the R,G and B parameters are entered, the gamut is displayed on the CIE chart. Completing the white point also displays it on the chart.

Chapter 10

Activity

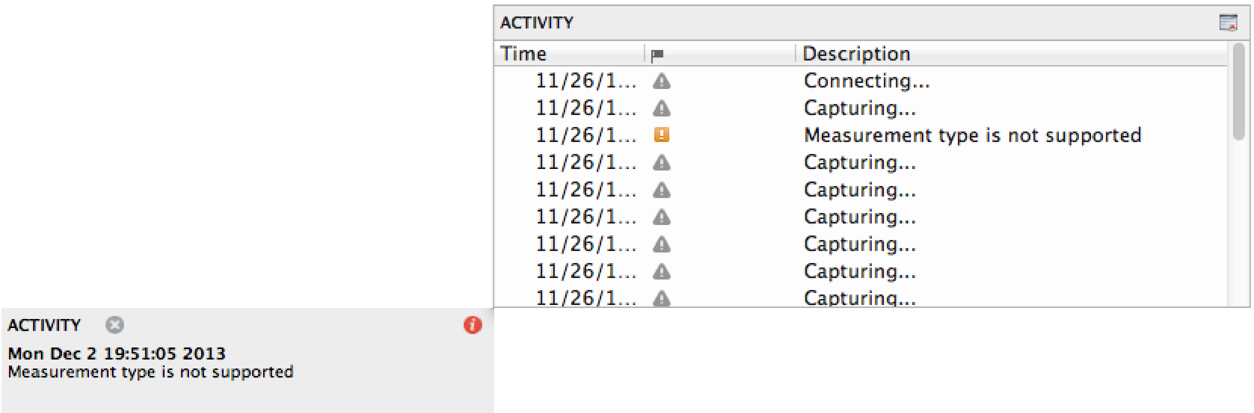

Figure 10.1 Actvity

10.1 Activity pane

The activity pane displays the activity time stamp and the description. Along with this the activity an icon indicating information, warning and error is displayed. When an error or warning occurs, the title area of the activity pane flashes three times using colors indicative of error/warning to draw attention to the message.

The following actions are available in the activity pane

- **Clear** - Clears the activity that is displayed in the activity pane.
- **Show activities** - Displays the activity list.

10.2 Activity list

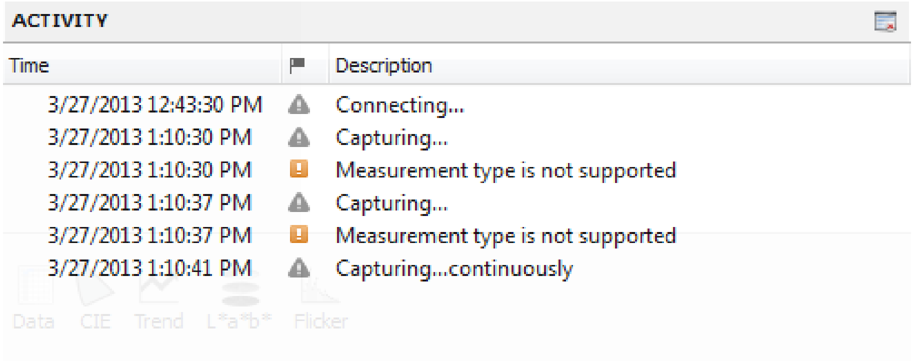

Figure 10.2 Actvity List

The activity list shows the status of all the activities for the entire application.

- **Time** - The date and time stamp of the status
- **Flag** - The type of status, such as information, warning or error
- **Description** - The description of the status

The following actions are available in the activity list

- **Clear** - Clears all activities displayed in the list.

Chapter 11

Calculations

CRIApp calculation notes are listed in this section

11.1 Standard

11.1.1 Luminous Flux

The luminous flux or luminous power is the quantity derived from radiant flux (radiant power) by evaluating the radiant energy according to its action upon a selective receptor, the spectral sensitivity of which is defined by a standard luminous efficiency function.

The SI (International System of Units) unit of luminous flux is lumen (lm).

$$P_v = K_m \int_{\lambda} P_{e,\lambda} V(\lambda) d\lambda$$

where:

$$\begin{aligned} K_m &= \frac{K(\lambda_d)}{V(\lambda_d)} \\ &= 683\, lm\, .\, W^{-1} \end{aligned}$$

$$P_{e,\lambda} = Spectral\ concentrations\ of\ radiant\ flux$$

11.1.2 Luminous Intensity

The luminous intensity in a given direction is the quotient of the luminous flux emitted by a point source in an infinitesimal cone containing the given direction, by the solid angle of the cone.

The SI (International System of Units) unit of luminous intensity is **candela (cd)**

$$I_v = K_m \int_\lambda I_{e,\lambda} V(\lambda) d\lambda$$

where:

$$\begin{aligned} K_m &= \frac{K(\lambda_d)}{V(\lambda_d)} \\ &= 683\, lm\, .\, W^{-1} \end{aligned}$$

$$P_{e,\lambda} = Spectral\ concentrations\ of\ radiant\ intensity$$

11.1.3 Luminance

The luminance at a point of a surface and in a given direction is the quotient of the luminous intensity in the given direction of an infinitesimal element of the surface containing the point under consideration, y the orthogonally projected area of the surface element on a plane perpendicular to the given direction.

The SI (International System of Units) unit of luminance is **candela per square meter (cd/m^2)** (sometimes called **nits**) A **footlambert (fL)** is a non-SI unit of luminance.

$$L_v = K_m \int_\lambda L_{e,\lambda} V(\lambda) d\lambda$$

where:

$$\begin{aligned} K_m &= \frac{K(\lambda_d)}{V(\lambda_d)} \\ &= 683\, lm\, .\, W^{-1} \end{aligned}$$

$$P_{e,\lambda} = Spectral\ concentrations\ of\ radiance$$

11.1.4 Illuminance

The illuminance at a point of a surface is the quotient of the luminous flux incident on an infinitesimal element of the surface containing the point under consideration, but the area of the surface element.

The SI (International System of Units) unit of illuminance is lm.m $^{-2}$ or lux. A **foot-candle (sometimes foot candle; abbreviated fc, lm/ft^2, or sometimes ft-c)** is a non-SI unit of illuminance which is also widely used.

$$E_v = K_m \int_\lambda E_{e,\lambda} V(\lambda) d\lambda$$

where:

$$\begin{aligned} K_m &= \frac{K(\lambda_d)}{V(\lambda_d)} \\ &= 683\, lm\, .\, W^{-1} \end{aligned}$$

$$P_{e,\lambda} = Spectral\ concentrations\ of\ irradiance$$

11.1.5 Radiance

11.1.6 Photon Radiance

11.1.7 Irradiance

11.1.8 Photon Irradiance

11.1.9 Radiant Intensity

11.1.10 Photon Radiant Intensity

11.1.11 Radiant Flux

11.1.12 Photon Radiant Flux

11.1.13 CIE 1931 - xy

This computation is for the 2° Standard observer.

The CIE XYZ color space was designed so that the Y parameter was a measure of the brightness or luminance of a color. The chromaticity of a color is specified by the two derived parameters x and y, two of the three normalized values which are functions of all three tristimulus values X, Y, and Z:

$$x = \frac{X}{X+Y+Z}$$

$$y = \frac{Y}{X+Y+Z}$$

11.1.14 CIE 1960 - uv

This computation is for the 2° Standard observer.

The CIE 1960 color space commonly called as the CIE 1960 UCS (Uniform Color Space) is another name for the (u, v) chromaticity space.

$$U = \frac{2}{3}X$$

$$V = Y$$

$$W = \frac{1}{2}(-X + 3Y + Z)$$

$$\begin{aligned} u &= \frac{U}{U + V + W} \\ &= \frac{4X}{X + 15Y + 3Z} \end{aligned}$$

$$\begin{aligned} u &= \frac{V}{U + V + W} \\ &= \frac{6Y}{X + 15Y + 3Z} \end{aligned}$$

$$u = u'$$

$$v = \frac{2}{3}v'$$

11.1.15 CIE 1976 - u'v'

This computation is for the 2° Standard observer.

CIE 1976 (L∗, u∗, v∗) color space, commonly known by its abbreviation CIELUV, is a color space adopted by the International Commission on Illumination (CIE) in 1976, as a simple-to-compute transformation of the CIE 1931 (xy) color space.

$$u = \frac{4X}{X + 15Y + 3Z}$$

$$v = \frac{9Y}{X + 15Y + 3Z}$$

$$u' = u$$

$$v' = \frac{3}{2}v$$

11.2 Transmittance

Transmittance is the fraction of incident light at a specified wavelength that passes through a sample.

The photometric transmittance is calculated as follows,

$$T_x = \frac{Y_{sample}}{Y_{source}}\%$$

where:

T_x = Photometric transmittance

Y_{sample} = Tristimulus Y of the sample measurement

Y_{source} = Tristmulus Y of the source measurement

When both the sample and source are spectral quantities the radiometric transmittance is calculated as follows,

$$T_\lambda = \frac{R_{sample}}{R_{source}}\%$$

where:

T_λ = Radiometric transmittance

R_{sample} = Integrated radiance of the sample measurement

R_{source} = Integrated radiance of the source measurement

11.3 Reflectance

Reflectance is the fraction of incident light that is reflected at an interface.

The photometric reflectance is calculated as

$$R_x = \frac{Y_{sample}}{Y_{source}}\%$$

where:

T_x = Photometric reflectance

Y_{sample} = Tristimulus Y of the sample measurement

Y_{source} = Tristmulus Y of the source measurement

When both the sample and source are spectral quantities the radiometric reflectance is calculated as follows,

$$R_\lambda = \frac{R_{sample}}{R_{source}}\%$$

where:

R_λ = Radiometric reflectance

R_{sample} = Integrated radiance of the sample measurement

R_{source} = Integrated radiance of the source measurement

11.4 Absorptance

Absorptance is the inverse of transmittance or reflectance.

The photometric absorptance is calculated as

$$A_b = \frac{Y_{source} - Y_{sample}}{Y_{source}}\%$$

where:

T_x = Photometric absorptance

Y_{sample} = Tristimulus Y of the sample measurement

Y_{source} = Tristmulus Y of the source measurement

When both the sample and source are spectral quantities the radiometric absorptance is calculated as follows,

$$A_\lambda = \frac{R_{source} - R_{sample}}{R_{source}}\%$$

where:

A_λ = Radiometric absorptance

R_{sample} = Integrated radiance of the sample measurement

R_{source} = Integrated radiance of the source measurement

11.5 Optical Density

Optical density (also called absorbance) of a material is a logarithmic ratio of the light falling upon a material, to the light transmitted through a material.

The photometric optical density is calculated as

$$O_d = log_{10}\frac{Y_{sample}}{Y_{source}}\%$$

where:

O_x = Photometric optical density

Y_{sample} = Tristimulus Y of the sample measurement

Y_{source} = Tristmulus Y of the source measurement

When both the sample and source are spectral quantities the radiometric optical density is calculated as follows,

$$O_\lambda = log_{10}\frac{R_{sample}}{R_{source}}\%$$

where:

O_λ = Radiometric optical density

R_{sample} = Integrated radiance of the sample measurement

R_{source} = Integrated radiance of the source measurement

11.6 Contrast

The contrast ratio is a property of a display system, defined as the ratio of the luminance of the brightest color (white) to that of the darkest color (black) that the system is capable of producing.

11.6.1 Contrast Ratio

The contrast ratio is calculated as

$$Contrast\ Ratio = \frac{Y_{light}}{Y_{dark}}$$

11.6.2 Raster Modulation (Weber Contrast)

Raster modulation or Weber contrast is commonly used in cases where small features are present on a large uniform background, i.e., the average luminance is approximately equal to the background luminance.

The raster modulation is calculated as

$$Raster\ Modulation = \frac{Y_{light} - Y_{dark}}{Y_{light}}\%$$

11.6.3 Depth of Modulation (Michelson Contrast)

The depth of modulation (also known as the Visibility or Michelson contrast) is commonly used for patterns where both bright and dark features are equivalent and take up similar fractions of the area.

The depth of modulation is calculated as

$$Depth\ of\ Modulation = \frac{(Y_{light} - Y_{dark})}{(Y_{light} + Y_{light})}\%$$

11.7 L∗a∗b∗

This calculation requires a reference white X_r, Y_r, Z_r.

$$L^* = 116\left(\frac{Y}{Y_r}\right)^{\frac{1}{3}} - 16$$

$$a^* = 500\left[\left(\frac{X}{X_r}\right)^{\frac{1}{3}} - \left(\frac{Y}{Y_r}\right)^{\frac{1}{3}}\right]$$

$$b^* = 200\left[\left(\frac{Y}{Y_r}\right)^{\frac{1}{3}} - \left(\frac{Z}{Z_r}\right)^{\frac{1}{3}}\right]$$

The color difference, or ΔE, between two colors $L^*{}_1a^*{}_1b^*{}_1$ and $L^*{}_2a^*{}_2b^*{}_2$ is:

$$\Delta E^*ab = \sqrt{(L_1^* - L_2^*)^2 + (a_1^* - a_2^*)^2 + (b_1^* - b_2^*)^2}$$

$$\Delta E^*ab = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$$

11.8 L*u*v*

This calculation requires a reference white X_r, Y_r, Z_r.

$$L^* = 116\left(\frac{Y}{Y_r}\right)^{\frac{1}{3}} - 16$$

$$u^* = 13L^*(u' - u'_r)$$

$$v^* = 13L^*(v' - v'_r)$$

The color difference, or ΔE, between two colors $L^*_1u^*_1v^*_1$ and $L^*_2u^*_2v^*_2$ is:

$$\Delta E^*uv = \sqrt{(L_1^* - L_2^*)^2 + (u_1^* - u_2^*)^2 + (v_1^* - v_2^*)^2}$$

$$\Delta E^*uv = \sqrt{(\Delta L^*)^2 + (\Delta u^*)^2 + (\Delta v^*)^2}$$

11.9 Flicker

11.9.1 Flicker Frequency

The temporal data is collected as intensity as a function of time. Using Fourier analysis the flicker intensity is calculated as a function of frequency. The dominant flicker frequency is the highest flicker peak as a result of the FFT (Fast Fourier Transform).

11.9.2 JEITA Flicker (JEITA (formerly EIAJ) flicker level, weighted level, ISO flicker)

Flicker characterization is compliant with the IDMS (Information Display Measurements Standard) published by the SID's (Society for Information Display) ICDM (International Committee for Display Metrology) working group. This includes the FFT (Fast Fourier Transform) method of calculating dominant flicker frequency and weighted flicker level to match the approximate temporal flicker sensitivity of the human eye.

Table 1. Flicker Weighting Factors Use linear interpolation between the listed frequencies. "Scaling: dB" is equivalent to "Scaling: Factor"

Frequency: Hz	Flicker Sensitivity: dB	Scaling: Factor
20	0	1.00
30	-3	0.708
40	-6	0.501
50	-12	0.251
≥60	-40	0.010

$$Weighted\ Flicker\ Level = 20log_{10}(2\frac{f[n]}{f[0]})$$

-OR-

$$Weighted\ Flicker\ Level = 10log_{10}(\frac{power[n]}{power[0]}dB.)$$

11.9.3 Photometric Flicker (IESNA)

The two metrics for calculating photometric flicker are Percent Flicker and Flicker Index.

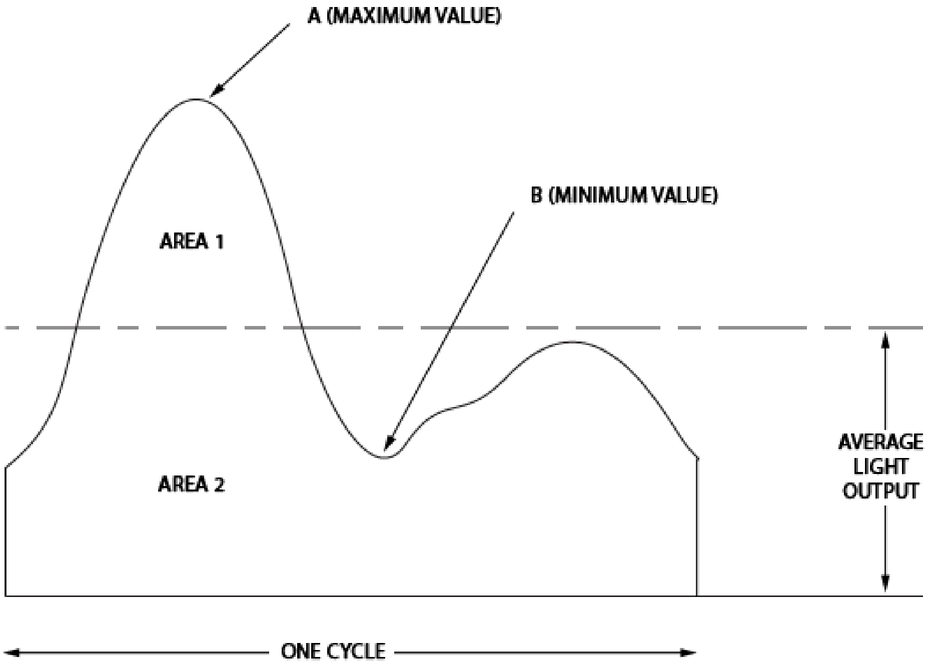

Figure 11.1 Periodic Waveform Reference for Traditional Flicker Metrics

11.9.3.1 Percent Flicker

Percent flicker, is the best known of the two metrics and is commonly used in lighting research literature, where it is also referred to as peak to peak contrast, Michelson contrast, or even just “modulation”.

$$\begin{aligned} Percent\ Flicker &= \frac{(Max - Min)}{(Max + Min)}\% \\ &= \frac{(A - B)}{(A + B)}\% \end{aligned}$$

11.9.3.2 Flicker Index

Flicker index, is generally preferred over and/or considered more reliable than percent flicker, as flicker index is mathematically able to account for differences in shape or duty cycle that the more simplistic percent flicker cannot.

$$\begin{aligned} Flicker\ Index &= \frac{Area\ above\ Mean}{Total\ Area} \\ &= \frac{Area\ 1}{(Area\ 1 + Area\ 2)} \end{aligned}$$

11.9.4 Flicker Modulation Amplitude

Flicker Modulation Amplitude is a simple flicker characterization by measuring the time-dependent amplitude modulation of the screen luminance filtered according to an empirical flicker sensitivity function based on frequency (Flicker Weighting Factors)

$$Flicker\ Modulation\ Amplitude = \frac{V_{max} - V_{min}}{V_{max}} x100\%$$

For small modulation amplitudes (less than 13 %)

$$Flicker\ Modulation\ Amplitude = \frac{V_{pp}}{V_{dc}} x100\% \ \ (for\ small\ signals\ only)$$

Chapter 12

Tools & Utilities

12.1 Authenticate

All exported data using the CRIApp are signed using a Public Key cyrptographic system to secure against tampering.

12.2 Colorimeter Utility

The Colorimeter Utility is an accompanying software tool that aids in updating, preserving and recovering the state of the instrument. It is also used to define a color correction based on the Four-Color Matrix Method Correction.

The Four-Color Matrix Method, developed by NIST improves the accuracy of tristimulus colorimeters for measurements of color displays and has been verified to be appropriate for CRTs, LCDs, and OLED displays.

12.2.1 Connection

12.2.2 Maintenance

The section explains the Backup and Recover of the instrument state and the Upgrade of the firmware.

12.2.2.1 Backup

The backup pane lists all the available items that are available for backup. Select by checking the items that are required to be backed up and archive will be created of the selection. The archive file will be automatically titled with the model and identifier of instrument specified within its configuration file.

Note

> The configuration is a mandatory item that is required for a valid archive.

12.2.2.2 Recover

The Recover pane is a drop-zone that accepts an archive file. Once an archive file is selected or dropped into the drop-zone, a list of items that can be recovered are displayed. Select by checking the items that are required to be recovered.

Note

The instrument will have to be restarted after a successful recovery.

12.2.2.3 Upgrade

The upgrade pane is a drop-zone that accepts an instrument operating system or firmware image. This is designated by a file with ‘cros’ extension. The utility validates the files signatures and uploads the image to the instrument. Once all the steps are verified the instrument is marked for installation. The installation takes place during the next power up cycle.

Note

The instrument will have to be restarted for a successful upgrade to take place.

12.2.3 User Calibration

12.2.3.1 Matrix

A list of calibration matrices will be displayed. Double clicking on an individual matrix calibration will show an ‘arrow’ icon which indicates that the selected matrix is the active calibration.

The following actions are available for calibration matrices. These actions are available ‘+’ icon menu.

- **Create matrix using a wizard** - Walks you through the steps of capturing the red (R), green (G), blue (B) and white point references and actual measurements.
- **Enter a known calibration matrix** - Enter the values for a known R-Matrix which will be used for calibration.
- **Create calibration matrix** - Manually capture the red (R), green (G), blue (B) and white points.
- **Select calibration matrix** - Select a predefined calibration matrix.
- **Import** - Import the calibration matrices from a file.
- **Export** - Exports the calibration matrices to a file.

Selecting a matrix allows you to remove it from the matrix collection using the ‘-’ icon. This displays the calibration matrix on the right with the option to make corrections using the **Edit** action button.

Note

The Matrix calibration is available only for colorimeters. The calibration matrices are dependent on selected accessory.

The matrix file format can contain the following types of data that

1. Matrix
2. Four color Matrix Method

The format of the Matrix data is as follows:

```
Name,M00,M01,M02,M10,M11,M12,M20,M21,M22
```

The format for the Four Color Matrix Method data is as follows:

```
Name,RefRed_x,RefRed_y,RefGreen_x,RefGreen_y,RefBlue_x,RefBlue_y,RefWhite↩
_Y,RefWhite_x,RefWhite_y,MeasRed_x,MeasRed_y,MeasGreen_x,MeasGreen_y,Meas↩
Blue_x,MeasBlue_y,MeasWhite_Y,MeasWhite_x,MeasWhite_y
```

Examples:

```
RMatrix,1,0,0,0,1,0,0,0,1
RMatrix2,0.334455,-0.017939,-0.0101598,0.0105013,0.291405,-0.000263817,0.↩
0110956,-0.00837607,0.298805
FCMM1,0.67,0.32,0.3,0.6,0.15,0.05,100,0.3,0.3,0.6711,0.3121,0.3174,0.↩
599,0.1603,0.0465,292.321,0.3161,0.3013
```

12.2.3.2 Match

A list of calibration matches will be displayed. Double clicking on an individual match calibration will show an ‘arrow’ icon which indicates that the selected match is the active calibration.

The following actions are available to create the calibration matrices. These actions are available ‘+’ icon menu.

- **Create calibration match** - Manually enter the calibration correction multiplier (XYZ) values.

Selecting a match allows you to remove it from the match collection using the ‘-’ icon. This displays the calibration match on the right with the option to make corrections using the **Edit** action button.

Note

The match calibration is available for photometers and colorimeters. For photometers only a photometric correction is available.

See also

Calibration procedure using CRIApp and Colorimetry Utility Match Calibration.

12.2.4 Setup

This pane shows the instrument setup. You can change the parameters of the setup. This is useful for taking measurements while defining the User Calibration.

See also

Setup, Connect & Disconnect

Chapter 13

Wavelength check procedure

This section walks you through the Wavelength Check procedure for Colorimetry Research Spectroradiometers

13.1 Prerequisite

13.1.1 Mercury (Hg) or Helium (He) gas lamp.

Any Mercury or Helium gas lamp can be used for this test. Colorimetry Research recommends and resells the Mercury gas lamp **Model ML-900** manufactured by `Electro-Technic Products Inc.`

13.1.2 Colorimeter Utility Version 1.41 or later

The Colorimeter Utility is parts of the CRIApp application package which can be downloaded from `http://www.colorimetryresearch.com/downloads/#application`

13.2 Wavelength Check procedure

- Place the rubber hood of the Spectroradiometer aligned and against the white diffuser of the ML-900 as shown on Figure one CR-250 with ML-90.

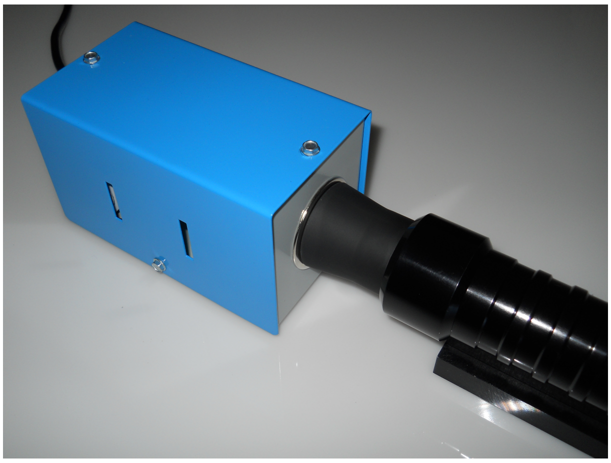

Figure 13.1 CR-250 with ML-900

- Follow the instructions on SECTION 2 – INSTALLATION of the ML-900 Operation Manual.
- Connect the Spectroradiometer USB cable to your computer, then run the Colorimeter Utility.
- Click on the Setup icon and set Sync: Manual 60 Hz (or 50 Hz depending on to the power line frequency of your country).

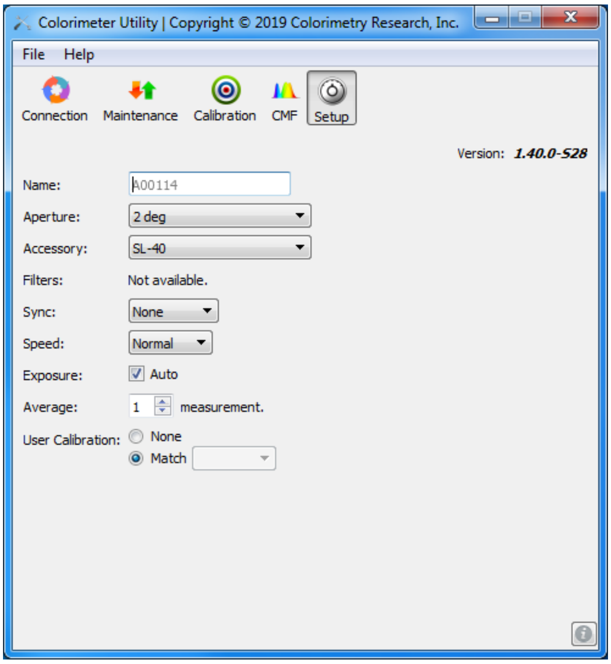

Figure 13.2 CR-250 Spectroradiometer Setup

- Click on the Calibration Icon and select the type of source you are using (Mercury or Helium).
- Click on Capture and wait for the instrument to perform a capture and return with a test result.

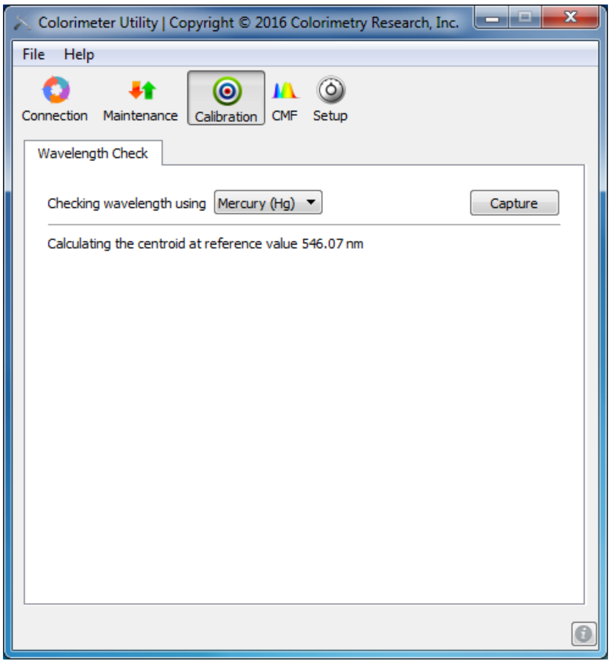

Figure 13.3 Wavelength check

13.3 Results

Possible results are Pass, Fail, or Warning

Pass	**Message: Wavelength accuracy is within factory specifications**	A pass doesn't warrant the unit is in perfect calibration but indicates that if there is some deviation this is usually small.
Fail	**Message: Wavelength accuracy does not meet factory specifications.**	A fail of the wavelength check is definitely an indication that the unit needs recalibration.
Warning	**Message: Reduced wavelength accuracy, unit should be recalibrated.**	
Error	**Message: Invalid measurement spectrum is encountered.**	

Chapter 14

FAQ

This section contains answers to some frequently asked questions about the CRI App. You might also find answers to your questions in the Known Issues section.

14.1 General Questions

14.1.1 How do I reset all my settings?

CRI App creates the following files and directories

- colorprofilemanager.data
- loggingmanager.data
- measurementmanager.data
- referencemanager.data
- CRI App.ini
- workspaces
  - Colorimeter.Workspace.data

The location depends on the platform.

On OS X the files are located in ~/.config/colorimetryresearch.com/ and ~/Library/Application Support/ColorimetryResearch/CRI App

On Windows XP, the files are located in <drive>:\Documents and Settings\<username>\Application Data\ColorimetryResearch\CRI App, and on Windows Vista and Windows 7 in <drive>:\Users\<username>\AppData\Roaming\ColorimetryResearch\CRI App You can try the shortcut LOCALAPPDATA%\ColorimetryResearch\CRI App For all versions, try the path %APPDATA%\ColorimetryResearch\

14.2 Measurement Questions

14.2.1 Contrast Measurements

Both the CR-100 and CR-200 can be used for contrast ratio measurements.

The CRIApp software provides a user friendly mode to setup Contrast measurements such that the user will be able to get the contrast number without having to perform manual calculations.

Note

> The CR-100 will measure contrast ratios as high as maximum display brightness (in footLamberts) x 1,000.00 with a $\pm$10% error. The precision of the measurement can be improved significantly by averaging measurement captures for the black level (additional measurement time = 500 milliseconds x number of captures averaged). A contrast ratio of maximum display brightness (in footLamberts) x 100.00 will be measured with $\pm$1% error.

Beware that some instrument manufacturers advertise and spec the contrast ratio capabilities of their instruments without specifying the display maximum brightness, instead they use the maximum brightness the instrument is capable of measuring. Following that logic, the CR-100 could measure a contrast ratio as high as 1,500,000.00 but this is false and misleading unless your display maximum brightness is 1,500.00 footLamberts.

14.3 Calibration Questions

14.3.1 Calibration procedure using CRIApp and Colorimetry Utility Match Calibration.

14.3.1.1 Match Calibration for Tristimulus Instruments

1. Setup your calibration source standard per manufacturer specifications.
2. Set the lamp current to the required value according to last calibration certificate.
3. Setup the CR-100 facing the exit port of your calibration source standard.
4. Make a measurement of Cie X, Y, Z using CRIApp. Write down the values as X_m, Y_m, Z_m.
5. Find the CIE X, Y, Z values of your calibration source standard provided in the last calibration certificate. You may need to calculate the X, Y, Z values of your source from Y (cd/m^2), x, y.
6. Name the CIE X, Y, Z of your calibration source standard X_s, Y_s, Z_s
7. Calculate the “Calibration Correction Multiplier” for X, Y, Z as follows:
   $X_c = X_s/X_m$, $Y_c = Y_s/Y_m$, $Z_c = Z_s/Z_m$
8. Use the Colorimeter Utility to create a Match Calibration, and give it a name associated with the calibration source, i.e. *“OL-455 June 17, 2014”*
9. Enter the Calibration Correction Multipliers calculated in **step 7**, X_c, Y_c, Z_c
10. Exit the Colorimeter Utility.
11. Run CRIApp and click on the Setup icon.
12. Select User Calibration: Match and select the Match Calibration you create in **step 8** above.
13. Make a measurement.
14. Verify that your new measured X_m, Y_m and Z_m match the calibration source values X_s, Y_s, Z_s, respectively.

14.3.1.2 Match Calibration for Spectral Instruments

Note

Spectral matching is an advanced feature used to calibrate a spectroradiometer to a reference spectrum.

A spectral file in a plain/ascii text format is required. Each line is followed by new line feed.

Line 1 (*optional*): **Name or description of the spectrum** eg. `Display measurement XYZ-45`

Line 2 (required): **Starting wavelength** eg. `380.0`

Line 3 (required): **Ending wavelength** eg. `780.0`

Line 4 (required): **Wavelength increment** eg. `1.0`

Line 5 - number of points (required): **Spectral data per wavelength increment** eg.
`3.465E-04`
`3.554E-04`
`3.647E-04`
etc...

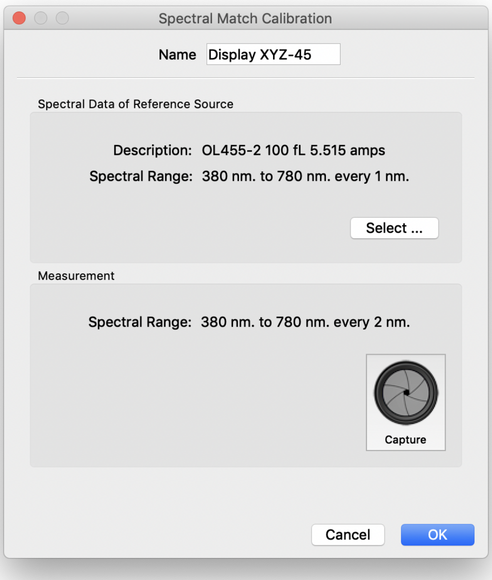

Figure 14.1 CR-250 Spectral Match Setup

1. Enter the name for your spectral match data.
2. Select a spectral text file containing the reference data. The reference data must be in the valid spectral range and have a wavelength increment, equal or better than the instrument being calibrated.
3. Setup and align the CR-250 facing target.
4. Capture a measurement
5. Selecing OK will automatically create a calibration and upload it to the instrument.

Chapter 15

Trouble Shooting & Support

This section will aid you to trouble shoot

Report all issues in detail to `support@colorimetryresearch.com`

In your support email list out the following details.

- **Operating system**
  - **OS X** - This is displayed in **About this Mac** in the menu.
  - **Windows** - List the Windows edition, Service pack, System type(32/64 bit)
    * From the Start Menu, right click on **Computer**
    * Click on **Properties**
    * This will take you to the system information screen
- **Application Version** - The CRIApp version

If the application crashes during startup, try How do I reset all my settings?

Chapter 16

Known Issues

This section will list out the known issues and their work arounds if any.

There are currently no known issues.