SPECTROMETER 012

USER'S GUIDE

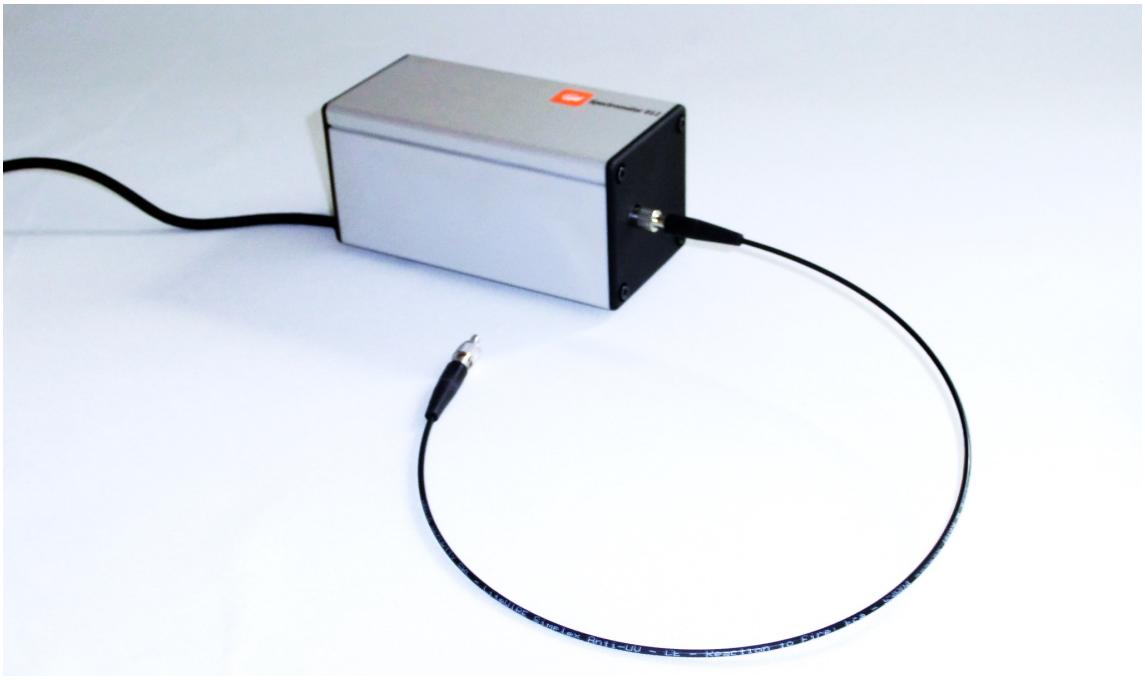
CENTRE FOR MICROCOMPUTER APPLICATIONS

https://cma-science.nl

Short description

The CMA Spectrometer 012 is an easy to use USB spectrometer, which allows measuring emission spectra of light sources such as light bulbs, discharge tubes or sun, over a wavelength range of 360 - 940 nm. A fiber optics cable with SMA (male) connectors and a collimator are provided with the device. The fiber optic cable is recommended for analyzing the emissions of discharge tubes.

The Spectrometer connects to a computer via the USB port; it draws power from the host computer, eliminating the need for an external power supply. The Coach 7 software controls it.



When the CMA Spectrometer is used together with the CMA Light Source then absorption and luminosity (fluorescence, phosphorescence) spectra of various materials can be measured. The CMA Light Source is not included and has to be purchased separately (art. code 012LS).

How the Spectrometer works

Light enters the spectrometer through the SMA connector or via a flexible fiber optics cable. The light passes the entrance slit, grating and through objective lens enters a light detector (camera). The specially selected transmission grating with fine trimmed entrance slit guarantees the high resolution and good reliability of the results. The optics split the light into its component wavelengths, which fall across the detector.

The Spectrometer acts as a camera and delivers a video image (1280 by 720 pixels). The principle of the measurement in the Coach software is to read rows of pixels from the video image and for each pixel compute the corresponding wavelength and light intensity. The place in the image to read the rows of pixels is defined by the **Measurement slit** which is displayed as a transparent rectangle on the video image. By default this slit is 20 pixels high and is positioned in the middle of the video image but both its position and height can be changed via the option **Settings**.

The calibration of the Spectrometer defines the relationship between the wavelengths in nanometers that corresponds to each pixel number of the video image (which is actually the x-coordinate of the pixel in the video image). The Spectrometer window displays the live image of the Spectrometer.

Calibration

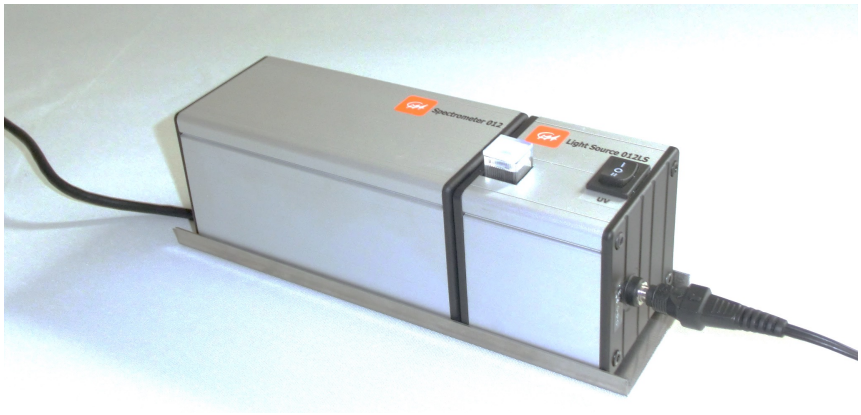
Each Spectrometer device has its own specific 3-points calibration, pixel number and respective wavelength per calibration point, that are written at the bottom of the device. The default calibration is always asked at the first start of the Spectrometer Activity in Coach 7 and is done by typing the 6 numbers.

Light intensity values in % are determined based on the RGB values of the pixels.

The CMA Light Source

The CMA Spectrometer 012 can also make transmittance or absorbance measurements when used together with the CMA Light Source 012LS. The Light Source 012LS consists of two different light sources – white LED and UV LED (400 nm). It has a built in cuvette holder, which is suitable for standard cuvettes for liquid samples or in which small solid materials can be placed. Ten standard cuvettes are included and a metal guiding rail is provided with the Light Source for proper positioning when connecting to the Spectrometer.

The CMA Light Source is **not** included with your Spectrometer and has to be purchased separately (art. code 012LS).



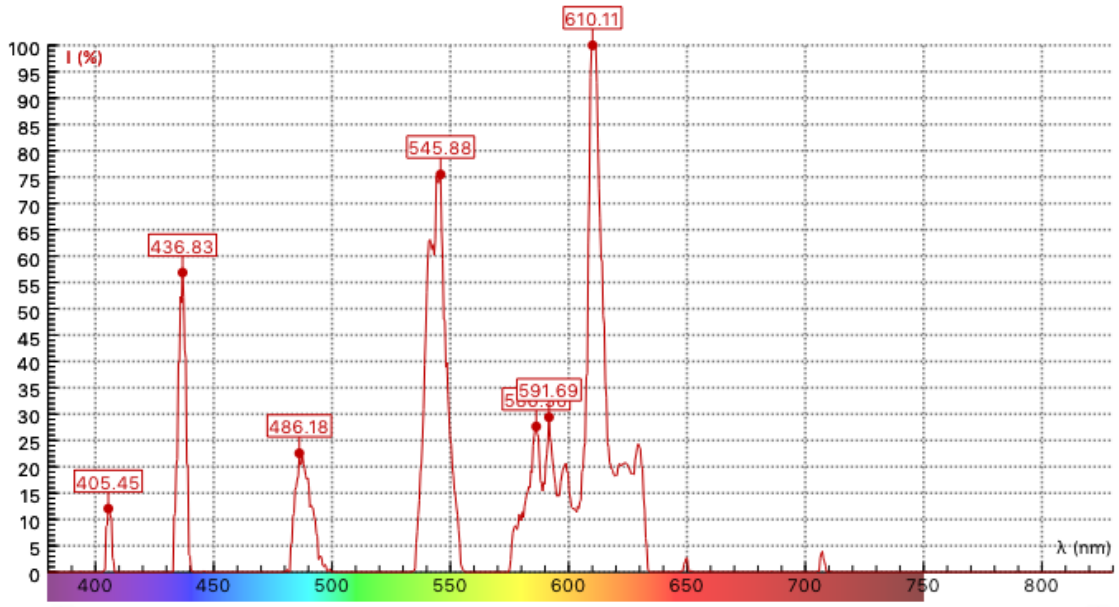
Recording Emission Spectra

The Coach 7 Activity of the type **Spectrometer > Emission Spectrum** allows recording and analyzing emission spectra from for example light bulbs or gas discharge tubes. The graph of light Intensity I versus wavelength λ is already predefined.

To record an Emission Spectrum in Coach 7

1. Connect the Spectrometer to the USB port of your computer.
2. Start Coach 7.
3. Create a new (only in the Author mode) or open an existing Activity of the type **Spectrometer > Emission Spectrum**.
4. If there is no live image shown in the Spectrometer window, click the tool menu option **Spectrometer >** and select the connected Spectrometer. When the Spectrometer is properly connected a live image should be shown in the window. If this is not the case check your connection or restart Coach again.
5. Each Spectrometer device has its own specific 3-points calibration, pixel number and respective wavelength per calibration point. These six calibration values are printed at the bottom of the device. Calibration is always asked at the first start of a Spectrometer activity and is done by typing these six values.
   To check the calibration:
   a. Select the tool menu option **Set Calibration**.
   b. Compare the numbers displayed in the dialog **Set the spectrometer calibration** with the numbers displayed at the bottom of your Spectrometer.
   c. If the numbers are different type in new values. Note that the new calibration will be in effect only for next measurements.
   d. Accept with **OK**.
6. Click the **Graph** icon and select the prepared Intensity versus wavelengths I(λ) graph. Display the graph in one of the panes. Below the graph a strip with colors is displayed.
7. Direct your Spectrometer to a light source or aim the tip of the fiber optic cable at the light source to get the image.
8. If needed:
   a. Modify the **Measurement Slit** visually on the live video image or click the **Settings** button. By default the slit is 20 pixels high and located in the middle of the image.
   b. In the **Settings** dialog modify the number of **Frames to average**. By default 1 is selected.
   c. Use the slider below the video image to set the **Exposure**. On some computers (often Mac computers) this option is not available. In such cases you may influence the brightness of the live image by changing the distance between a Spectrometer and a light source.
9. When you are satisfied with your image click the activity toolbar button **Start** and record a spectrum. The first run appears in the graph and in the data table.
10. At the same moment a spectrum image is taken. To see the image click the tool menu of the Spectrometer window option **Spectrum Image > Run 1**. Then the image is displayed in the Spectrometer window.

11. The same image with the name **Spectrometer image for Run 1** is available after clicking the activity toolbar button **Image** . This image can be placed in any of the Coach panes.
12. If you want to record another Emission spectrum check if the live image is selected. If not then select it via the tool menu option **Live Spectrum**.
13. Each time you click the **Start** button the data are collected again and a new run is added to the graph and data table, and a new spectrometer image is added to the list of images.
    Note that when a Run is removed , its respective image will be removed also.
14. Once you have collected your data you can analyze your spectrum.
15. A very useful option for spectral analysis is the option **Show peaks values**. It finds peaks in the spectrum and labels them with the respective values of wavelength. This option is not set on by default. To turn this option on:
    a. click the graph toolbar **Graph Properties** button or select the graph tool menu option **Graph Properties**,
    b. click tab **I**,
    c. check the option **Show peak values**, and
    d. click **OK** to accept. The peaks in the graph will be now labeled with the values of wavelength λ.
16. Save your results via the activity toolbar button **Save As** .



Emission spectrum of an energy saving lamp.

Recording Absorption Spectra

An Activity of the type **Spectrometer > Absorption Spectrum** allows recording and analyzing Absorption spectra. In this type of activity three graphs are already predefined: Light Intensity versus wavelength I(λ), Transmittance versus wavelength T(λ) and Absorbance versus wavelength A(λ).

In Coach Transmittance is calculated as **T= I / (I_0 - I_d)** and Absorbance as **A = log (1/T)**, where:

I_d - light intensity values recorded for the dark spectrum (no source light present). These values are also stored as variable I_d in the data table (by default the variable is hidden).

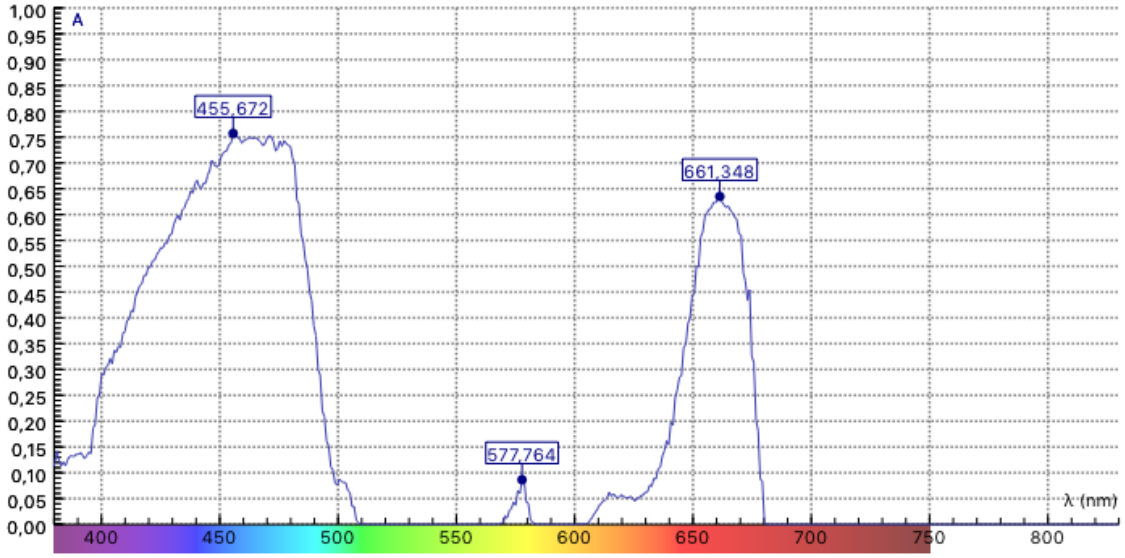
I_0 - light intensity values recorded for the reference (for a cuvette filled with the solvent). These values are also stored as the variable I_0 in the data table (by default the variable is hidden).

To record an Absorption Spectrum in Coach 7

1. Connect the Spectrometer to a USB port of your computer.
2. Connect the Light Source with cuvette holder to the Spectrometer.
3. Start Coach 7.
4. Create a new (only in the Author mode) or open an existing Activity of the type **Spectrometer > Absorption**.
5. If there is no live image shown in the Spectrometer window click the tool menu option **Spectrometer >** and select the connected Spectrometer. When the Spectrometer is properly connected a live image should be shown in the window. If this is not the case check your connection or restart Coach again.
6. Each Spectrometer device has its own specific 3-points calibration, pixel number and respective wavelength per calibration point. These six calibration values are printed at the bottom of the device. Calibration is always asked at the first start of a Spectrometer activity and is done by typing these six values.
   To check the calibration:
   a. Select the tool menu option **Set Calibration**.
   b. Compare the numbers displayed in the dialog **Set the spectrometer calibration** with the numbers displayed at the bottom of your Spectrometer.
   c. If the numbers are different type in new values. Note that the new calibration will be in effect only for next measurements.
   d. Accept with **OK**.
7. Turn off the light source and record a dark spectrum.
   a. Click the toolbar button **Record Dark Spectrum**  or select the tool menu option **Record Dark Spectrum**.
   b. The icon displayed on the button changes into  and the option is checked - the dark spectrum has been recorded.
8. Insert a cuvette filled with the solvent (water) and record reference spectrum.
   a. Click the toolbar button **Record Reference Spectrum**  or select the tool menu option **Record Reference Spectrum**.
   b. The icon displayed on the button changes into  and the option is checked - the reference spectrum has been recorded.
9. You are now ready to record absorption spectra. Rinse the cuvette with the solution to be tested and fill it with the same solution. Insert the cuvette into the cuvette holder.
10. Click the **Graph** icon  and select the **A** graph. Display the graph in one of the panes. Below the graph a strip with colors is displayed. In the similar way you can also select

the **T** and **I** graphs.

11. If needed:
    a. Modify the **Measurement Slit** visually on the live video image or click the **Settings** button. By default the slit is 20 pixels wide and located in the middle of the image.
    b. In the **Settings** dialog set the number of **Frames to average** (by default 1 is selected).
    c. Use the slider below the video image to set the **Exposure**. On some computers (often Mac computers) this option is not available.
    d. Adjust the concentration of the solution if the spectrum is too low or too high.
12. When you are satisfied with your image click the activity toolbar button **Start** and record a spectrum. The first run appears in the graphs of A(λ), T(λ) and I(λ) and in the data table.
13. At the same moment a spectrum image is taken. To see the image click the tool menu option **Spectrum Image > Run 1**. Then the image is displayed in the Spectrometer window.
14. The same image with the name **Spectrometer image for Run 1** is available after clicking the activity toolbar button **Image**. This image can be placed in any of the Coach panes.
15. If you want to record another Absorption spectrum check if the live image is selected, if not then select it via the tool menu option **Live Spectrum**.
16. Each time you click the **Start** button the data are collected again and a new run is added to the graph and data table, and a new spectrometer image is added to the list of images.
17. Note that when a Run is removed, its respective image will be removed also.
18. Once you have collected your data you can analyze the data.



Absorption spectrum of alcohol extraction of Robinia pseudo-acacia leaves.

Technical Specifications

Spectral range	360 – 940 nm
Optical resolution	< 1.5 nm FWHM
Graphics resolution	1280 x 720
Dimensions	60 mm x 60 mm x 125 mm

Warranty:

The Spectrometer 012 is warranted to be free from defects in materials and workmanship for a period of 24 months from the date of purchase provided that it has been used under normal laboratory conditions. This warranty does not apply if the product has been damaged by accident or misuse.

Note: *This product is to be used for educational purposes only. It is not appropriate for industrial, medical, research, or commercial applications.*

Rev. 18/02/2022