Supelco®
Analytical Products

TLC Explorer

Documentation System

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Operational User Manual

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MilliporeSigma

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1 Introduction

1.1 Intended Use of TLC Explorer

The TLC Explorer is designed to document and evaluate thin-layer chromatographic plates. It offers a safe, fast and flexible way to visually inspect and digitally record images of TLC plates after their chromatographic development workflow in the laboratory. For detecting different substance classes, the device contains three different LED light sources which illuminate the plates from above in direct-light mode:

- **White light** is used for the detection of visible, colored substances on thin-layer chromatograms.
- **UV-A** (366 nm) is typically used to stimulate fluorescence. Under this illumination, fluorescent substances and objects appear as bright, different colored spots on a dark background.
  It can also be used for plates which are pre-coated with the special fluorescence indicator F366. The substances, in this case, appear as dark or colored spots on a bright background. Other fluorescence indicators, like F254, do not fluoresce under this light and therefore do not interfere with the measurement.
- **UV-C** (254 nm) illumination is used almost exclusively for thin-layer chromatograms. Substances which absorb this light appear as dark spots on a bright background if the plate is pre-coated with an appropriate F254 fluorescent indicator.

Recorded plate images can be evaluated to generate reports or export the data for further processing with other systems.
The TLC Explorer was developed for use in the laboratory and to be operated by trained and skilled users to perform thin-layer chromatography. Only fully dried TLC plates with a maximum size of 20 x 20 cm should be used.
Please note, that any other use than the intended one described above invalidates claims under warranty.

1.2 Safety and Handling Instructions

Operational safety has been a primary objective when developing the TLC Explorer. However, it can only be guaranteed if the device is operated strictly according to the instructions given in this manual. Furthermore, any operation conflicting with the safety instructions given in this manual may invalidate claims under warranty. All personnel responsible for installation, use and maintenance must therefore read this operating manual carefully before working with the TLC Explorer and keep it at hand for later reference.

1.2.1 Do NOT Operate the TLC Explorer if ...

Before connecting the TLC Explorer to a power supply, ensure **none** of the following applies:

- The device has been stored under adverse conditions over a lengthy period of time.
- The device has been damaged in transport or by incorrect handling (e.g. dropped during transport or contact with liquids).
- Any part of housing, front unit, back cover, drawer, or Baseplate is wet, damaged, or deformed.
- The UV protection inspection window is missing, damaged or deformed.
- The device does not stand on a dry, flat, and stable surface.
- The drawer cannot be extended fully or does not close correctly.
- The foam pad inside the device (used as transport protection) has not been removed.
- The back cover is not mounted properly, and all four screws fastened.
- Any connector (USB-C, USB-A, Ethernet, and WiFi Antenna) or cable is wet, damaged, or deformed.
- The power supply is none of the recommended two adapters (USB-C power adapter DELL HA65NM170 or power bank DELL PW7018LC or Targus APB081).
- The device is significantly colder than its environment, such that humidity could condensate and damage electric circuits (please wait until device reaches room temperature).
- The device environment temperature lies outside the specified 15 - 40°C or the relative humidity outside the specified 20 - 80%.
- The device is, or has been, exposed to acidic, alkaline, solvent vapors or other gasses that may cause corrosion.
- Liquids, or other materials, have been spilled on or in the device. If so, remove them immediately. Make sure that the device is not damaged and completely dry before using it again.

If you expect any of the issues above apply to your device, do not connect, power up or operate. For questions on how to proceed, please contact the supplier of your TLC Explorer or visit the TLC Explorer service site using the link in figure 1.1:

Figure 1.1: Find the TLC Explorer service page at:
https://sigmaaldrich.com/TLCservice

1.2.2 Installation Requirements

For a safe and reliable operation, please follow the following guidelines when setting up the device in your laboratory:

- The device must be installed on a flat and dry lab bench suitable to support the weight of about 10 kg of the device.
- Do not expose the instrument to any strong vibration or shock.
- Protect the instrument from excessive dust.
- Locate the TLC Explorer, cables, and, if applicable, the power bank, at a safe distance from heating sources (e.g. gas burners, electric heaters or ovens), chemical substances (e.g. solvents) or other devices which could cause damage to them.
- To power the device, use only the USB-C power adapter DELL HA65NM170 or power bank DELL PW7018LC or Targus APB081, and connect them to the USB-C port at the back of the device.
- Connect the power source to a grounded outlet located within 2 meters of the device, following the regulations for the use of electronic devices in your laboratory.
- The line voltage at the user location must meet the specifications stated on the power adapter.
- Do not place the instrument near equipment that generates intense magnetic fields such as electric welding equipment, high frequency furnaces, pole transformers, etc.
- Connect the instrument to power lines that are free from sudden changes or voltage fluctuations.
- In case power motor driven equipment (such as a stirrer or shaker) must be connected to the same power line as your TLC Explorer, ensure that a noise reduction unit is installed.
- Ensure that cables are arranged in a way that they neither pose a risk to the staff working with, and around, the device, nor that they are accidentally drawn from their respective sockets.
- There must be enough space in front of the device to open the drawer completely and handle the Baseplate in a safe and convenient way.
- Place the device on a height that allows users to conveniently look through the inspection window. Avoid reflections of external light sources on the glass front that disturb the view through the inspection window.
- The device should only be used in an environment and operated in a manner that meets all official lab safety requirements.

1.2.3 Ultraviolet Radiation Exposure

Ultraviolet radiation, used in TLC plate Evaluation to stimulate fluorescence, can cause damage to eyes and skin. Safety regulations in most countries therefore demand that eyes and skin are protected from hazardous UV radiation. The TLC Explorer incorporates several safety measures to ensure that no UV-A or UV-C light leaks from the device when used as described in this manual. Under no circumstances try to circumvent these safety measures!

- Only look at TLC plates under UV illumination through the UV-protection inspection window.
- Ensure the inspection window is not damaged or deformed.
- Before activating UV illumination, check that the drawer and back cover are correctly closed and not damaged.
- Never operate the illumination unit outside the TLC Explorer.
- Follow general laboratory safety regulations for working with UV light.

1.2.4 General Notes on Handling

- Ensure the device has at least 30 seconds available to completely shut down before unplugging the power supply – similar to a desktop computer.
- Only TLC Plates without solvent residue can be documented – please ensure the TLC Plate is completely dry after the previous chromatographic development or derivatization step.
- Do not place objects higher than 8 mm on the Baseplate, as it might damage the device when closing the drawer and would be out of focus for image capture.
- Never lift or carry the device by holding the drawer handle. Instead, hold it on the bottom and grab the rubber feet to prevent it slipping out of your hands.
- Close the drawer whenever the device is not in use to avoid damages and contamination.
- When the TLC Explorer is being transported, the TLC Explorer must be closed, the Baseplate removed. No TLC plate should be inserted.
- Only attach FAT32 formatted USB sticks to USB-A ports for backups and updates. Do not use external HDDs nor any other media connected via a cable.
- Except for the replacement of the illumination unit (see section 10.4), the TLC Explorer shall only be opened, adjusted, or repaired by specialist personnel authorized by the manufacturer. Noncompliance invalidates any claim under warranty.
- Retain the original packaging, including the inner packaging, to protect the instrument against physical impact if it must be transported; especially for warranty claims. Please note, that damage caused by improper transport voids all warranty claims.

1.2.5 User Management and Information Security

It is assumed that the devices are placed in laboratories where physical access is limited to authorized staff only. To give priority to a smooth and efficient laboratory workflow, the TLC Explorer, therefore, features no means to restrict access to specific users or protect data with passwords or encryption. User accounts mainly serve to structure recorded data. There is no administration account with special privileges.

Any person with physical access or network connection to the device can

- create new users
- delete or login as an existing user
- access and delete all stored data
- initiate a restart or shut down of the instrument
- change device settings (incl. connectivity parameters)
- conduct a factory reset.

Depending on how you choose to integrate the TLC Explorer in your IT environment (see section 8), a large group of users may have access to your device(s). If the TLC Explorer is connected to a LAN or a WiFi network, usually everyone with access to that network can also open the user interface and login as an existing or new user (see section 3.4). If confidentiality is a concern, copy the respective data to your desktop or tablet, and then remove it from the TLC Explorer.

- Plan and test carefully the TLC Explorer connectivity settings to ensure only authorized and trained personnel have access.
- Download or copy your data to a memory stick and then save it at an external storage location. Do not use the TLC Explorer for permanent data storage.
- Only apply verified updates from the manufacturer.
- Only attach USB memory sticks (flash drives) you are certain do not contain malicious software.

1.3 A Short Introduction to TLC

Thin-layer chromatography (TLC) is a fast, easy-to-use, and highly versatile separation technique for qualitative and quantitative analysis. It is ideal for rapid identification, screening, and reaction monitoring. Its high matrix tolerance and the possibility to separate many samples in parallel makes TLC highly time and cost-efficient. It is widely used for both qualitative and quantitative sample analysis. TLC can be used to analyze virtually any substance class, including pesticides, steroids, alkaloids, lipids, nucleotides, glycosides, carbohydrates, and fatty acids.

1.3.1 The TLC Working Principle

The general thin-layer chromatography process is simple, as demonstrated figure 1.2.

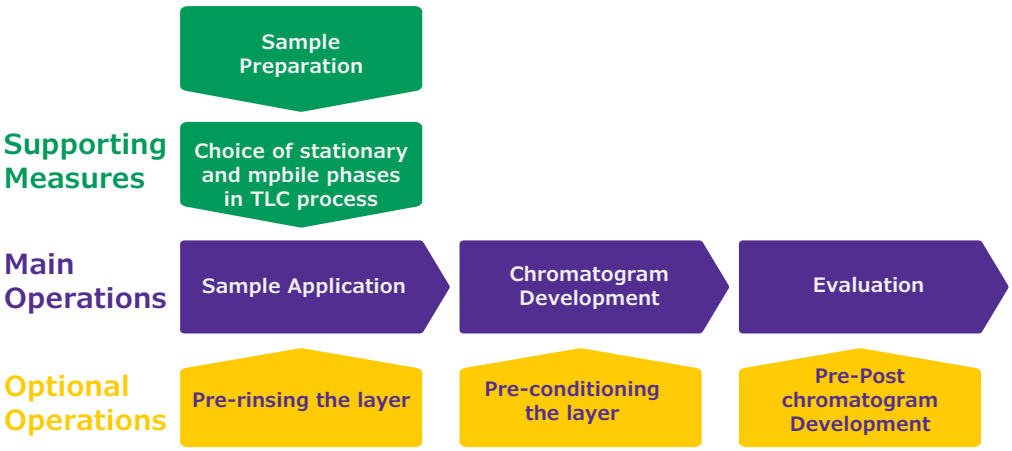


Figure 1.2: TLC process: preparation of of the layer (plate), sample preparation, choice of stationary phase, choice of mobile phase, sample application, development, derivatization, documentation

The key step in the workflow is the chromatographic process. TLC is based on the classic chromatography principle where mixture components are separated between a fixed stationary phase and a liquid mobile phase by differential affinities between the two phases. This is usually a thin adsorbent material layer, like silica gel or aluminum oxide, coated onto an inert plate surface, typically glass, plastic, or aluminum. The sample is spotted onto one end of the TLC plate (start line) and placed vertically into a closed chamber with an organic solvent (mobile phase). The mobile phase travels up the plate by capillary forces, and sample components migrate varying distances based on their differential affinities to the stationary and mobile phases. When the solvent reaches a specific height at the upper third of the plate, the plate is removed from the developing chamber and dried. The separated components appear as spots on the plate and the retardation factor (R_f) of each component is assessed.

1.3.2 Retardation Factor R_f

R_f is defined as the distance travelled by an individual component divided by the total distance travelled by the solvent; its value is always between zero and one. To avoid the decimal point, the retardation factor can also be multiplied by 100 and then is referred to as hR_f.
In general, the stronger a compound binds to the stationary phase adsorbent, the slower it migrates up the TLC plate. As TLC adsorbents are typically polar, non-polar compounds tend to travel more rapidly up the plate, resulting in a higher R_f values, whereas polar compounds tend to move slowly and have lower R_f values. Ideal mobile phases transport all components off the baseline having final R_f values between 0.15 and 0.85.
When separated sample components are colorless, or do not respond to UV radiation, and do not fluoresce, a derivatization or visualization of the analytes is done by using an appropriate detection reagent prior to analysis and documentation.
The TLC Explorer Documentation system offers a convenient solution for reliable TLC plate analysis, data handling and data storage.

1.4 About this Manual

The following sections are structured to first familiarize you with the device hardware (section 2), and guide you through the process of putting the TLC Explorer into service (section 3), before looking at typical workflows and the software use (section 4). Please read section 10.1 to know the recommended procedures on how to clean your device.
All further sections can be consulted as needed, providing technical details on device settings (section 5), user and data management (sections 5 and 6) and troubleshooting (section 9).
Section 8 'Connecting the TLC Explorer' is written to help IT specialists integrating the device(s) into your IT environment.
If you are unsure what a specific term means in the context of this manual, please refer to the Glossary (section 11). You can also find additional information there on the technology and algorithms used to generate and process the data.
When referring to specific elements on the device – like buttons or connectors – the manual often includes the **ID** used in the 'Device Overview' (section 2). You can easily locate these elements on your device by looking at figure 2.1 where IDs start with an **F** for 'front', figure 2.2 where IDs start with a **B** for 'back' or figure 2.3 where IDs start with a **P** for 'plate'.

2 Get to Know Your TLC Explorer

2.1 TLC Explorer Front

Figure 2.1: Identifying elements on the device front

2.1.1 F1 - Power Button

To start or switch off the device, place a finger for at least two seconds on the power icon **F1** (touch sensitive button). The light under the icon will flash for a few seconds while the device is booting or shutting down.
A dim white light indicates the device is connected to a power supply, yet shut off. The more brightly shining icon indicates the device is on and ready for use.
Please remember to shut down the device by pressing the button (or selecting 'Shutdown' in the software) and wait for the flashing icon to stop before unplugging the power supply.

2.1.2 F2, F3, F4 - Illumination Buttons and Indicators

Placing your finger on the circle to the right of the button labels 'Vis', '366' and '254' switches the respective illumination on or off. Only one of these light sources can be active at a time. A light under the circle indicates an illumination is switched on – be it manually by the user after pressing the button or controlled by the software to capture images.
For details on the emission spectra of these light sources, please refer to section 12.2.
Please note that the illuminated plate is only visible through the inspection window **F7** while the shutter slider **F8** is pushed down. The illumination buttons only switch light sources on/off for visual inspection, they do not capture images.
Safety features automatically switch off light sources and disable these buttons if UV light could leak from the device, e.g. because the drawer **F5** is not correctly closed, or the back cover **B7** is not correctly installed.

Vis: The button **F2**, labeled 'Vis', switches to the white light LED illumination.

366: Pressing on **F3** switches to UV-A LEDs to see substances showing fluorescence when illuminated at a wavelength of 366 nm.

254: Button **F4** switches to UV-C LEDs emitting at a wavelength of 254 nm. Use this light source to see substances absorbing this wavelength and thus appearing as dark spots on TLC plates with a F254 fluorescent indicator.

2.1.3 F5, F6 - Drawer and Drawer Open Indicator

Gently pull at the middle of the handle to open the drawer **F5**. If the device is on, you should notice the red icon F6 illuminated under the power icon **F1**. This red light is on whenever sensors indicate that the drawer is not closed correctly. While the drawer is open, light sources cannot be switched on and no images can be taken.
To place TLC plates on (or remove them from) the Baseplate, open the drawer completely. Arrange and align the plates on the Baseplate, and then gently push against the middle of the drawer handle until you feel a slight resistance. The drawer is designed to close the last few centimeters on its own. A special damper system takes care to correctly close the drawer without shifting the plates.
Opening the drawer while the system is recording images causes the software to display an error message and to abort the capture process.

2.1.4 F7, F8 - Inspection Window and Shutter Slider

A fast, yet safe, way to see TLC plates under UV (or visible) light is to switch on the desired light source (**F2**, **F3**, or **F4**) and then gently push down the shutter slider **F8** to look through the inspection window **F7**.
The shutter only opens an area about half the size of the inspection window. This is done to reduce disturbance from stray light entering the device while the user is looking through the inspection window. By pushing the shutter slider fully or only partly down, different parts of the Baseplate can be seen.

2.2 TLC Explorer Back

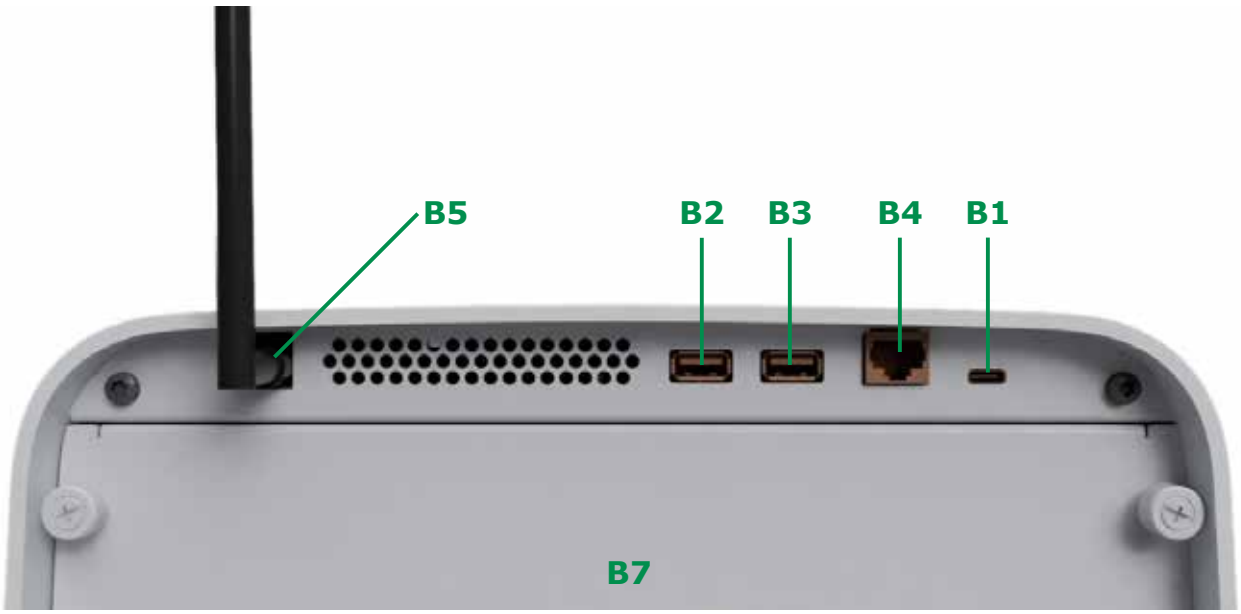


Figure 2.2: Identifying elements on the device back

2.2.1 B1 – USB-C Port for Power Supply

The USB-C port **B1** on the back's top right side solely serves to connect the power supply and features no data transfer. After connecting either of the recommended power supplies (USB-C power adapter DELL HA65NM170 **A2** or power bank DELL PW7018LC **A4**), the power icon **F1** on the front should light up in the dimmer state to indicate that the device is ready to be switched on.

2.2.2 B2, B3 - USB-A Ports

You can use the left (**B2**) or right (**B3**) USB-A port to connect memory sticks (flash drive) for backups or software updates. Do not use external hard-drives or other media connected via a cable. Please ensure to use only memory sticks that are free of malicious software.

2.2.3 B4 - Ethernet Port

Depending on your preferences, your TLC Explorer can connect to external devices via WiFi (mainly tablets and mobile devices) or Ethernet (e.g. desktop computers in a local network / LAN). To use the Ethernet option, connect a regular Cat5 or Cat6 cable to the RJ45 port **B4** and configure the TLC Explorer and, if needed, your local network according to the recommendations in section 8.2.

2.2.4 B5 - WiFi Antenna Connector

Each TLC Explorer is shipped with a separate WiFi antenna **A1**. In order to connect the antenna to the device, straighten up the joint at the antenna's base and screw it clockwise on the RP-SMA connector **B5** on the back's top left side. You can then align the antenna to optimize the reception and the space taken.
For details on how to configure the WiFi connection, please refer to sections 8.1 or 8.3.

Figure 2.3: Mounting the WiFi antenna

2.2.5 B6 - Serial Number

The sticker **B6** on the back (next to the USB-C port) identifies the specific device with its serial number. It should be identical with the serial number displayed on the software's 'Settings' page under 'Network'.
The QR code below the serial number includes a link to the full device label, which is physically situated on the bottom of the device.

2.2.6 B7 - Back Cover

The back of the TLC Explorer is closed correctly with the cover **B7** held by 4 knurled screws. This cover should only be opened to clean the device inside (please see section 10.1) or exchange the illumination unit (section 10.4). All 4 screws are attached to the back to simplify the handling. Please note that safety measures disable all light sources and thus the taking of pictures if sensors detect the back cover is not closed correctly.

2.2.7 B8 - Illumination Unit

The illumination unit **B8** is only visible when the back cover **B7** is removed (see figure 10.3). It houses the LED light sources for the different illumination types and is the only exchangeable part of the instrument.

To check if your illumination unit needs replacing, and how to perform the exchange in a safe way, please consult section 10.4 of this manual.

2.3 TLC Explorer Baseplate

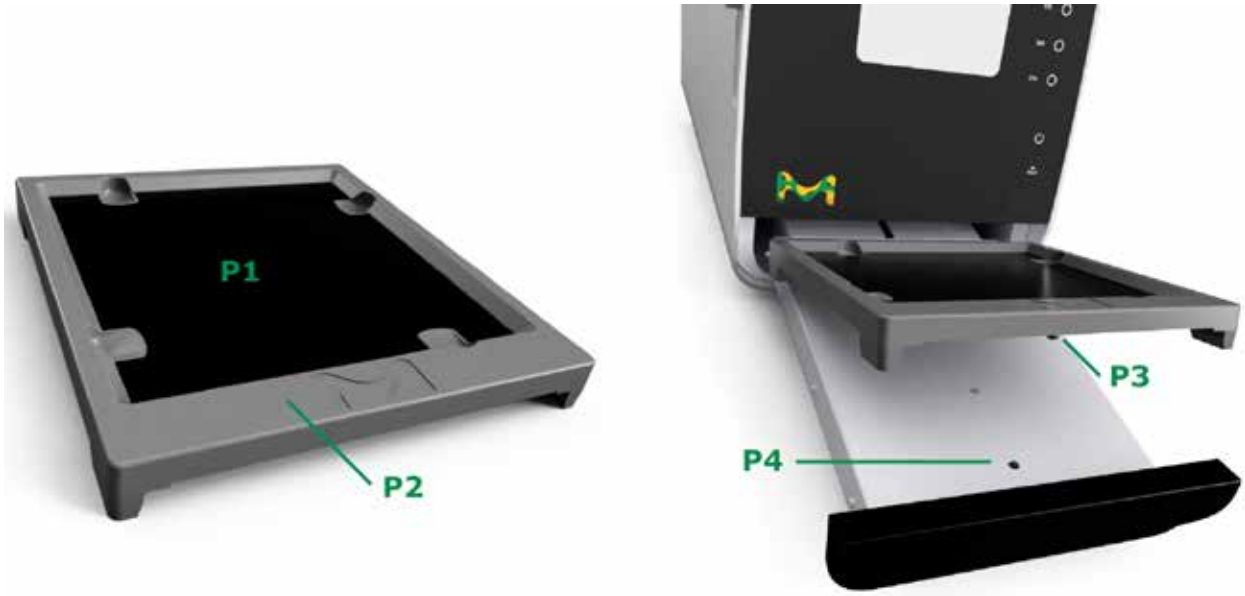


Figure 2.4: Identifying elements on and related to the Baseplate

2.3.1 P1 - Plate Area

Place TLC plates you plan to document directly on the plate area **P1**, without any other material, like paper or foil below them – the black coating is part of the optical instrument and is needed to detect plates automatically. Ensure that the plates are positioned flat on the plate area and do not protrude beyond the frame. Never place objects on the plate area that are higher than the Baseplate's frame **P2** (ca. 8 mm), as it might damage the device when closing the drawer and would be out of focus for image capture.
The area is large enough to hold one 20 x 20 cm TLC plate or multiple smaller plates. To get multiple plates detected automatically, place them a few millimeters apart, such that the device detects at least 2 mm of the black coating around each plate.
Depending on preferences, you may place TLC plates on the Baseplate while it is on the drawer, or move it to another location, place the plates there, and then insert the Baseplate together with the TLC plates as you arranged them.
Recessed grips on all 4 sides of the plate area allow the user to lift the TLC plates from the Baseplate without touching the TLC plate's coated surface.

2.3.2 P2 - Frame

The plate area **P1** is surrounded by a frame **P2** to simplify the holding and transport of the Baseplate. No object on the plate area should be higher than the frame height when inserting the Baseplate with the drawer.

2.3.3 P3, P4 - Alignment Pin and Socket

An alignment pin **P3** underneath the plate area helps the user to orient and align the Baseplate correctly on the drawer. Before closing the drawer, ensure that the pin **P3** has entered the socket **P4** on the drawer, so that the Baseplate lies flat on the drawer.

2.4 Accessories

2.4.1 A1 - WiFi Antenna

To provide a reliable WiFi connection, the TLC Explorer comes with an external antenna **A1**, which needs to be mounted on the connector **B5** (see section 2.2.4 for details).

2.4.2 A2, A3 - Power Adapter and Cords

Figure 2.5: Power adapter and cords

The packaging includes an USB-C power adapter **A2** and a set of power cords **A3** to connect the adapter to the power grid. Please select the power cord that fits your local power outlets. The power adapter can work with an input voltage of 100 to 240 V AC at 50 or 60 Hz.
Before connecting the power adapter to the power grid, check that the selected power line is free from sudden changes or voltage fluctuations (see also section 1.2.2). Once the power adapter is connected to the grid, plug the USB-C connector to the socket **B1** on the back of the device. If the power indicator **F1** lights up on the front, the device is ready to boot.

2.4.3 A4 - Power Bank

Figure 2.6: Power bank - not included in scope of delivery

The power bank **A4** is not part of the scope of delivery, but can be purchased separately (see section 10.3) to supply the TLC Explorer with electric power where no power outlets are available. When fully charged, the power bank provides sufficient power for about 30 hours of working with the TLC Explorer.

While the independence from a power grid when using a power bank enables a higher degree of mobility, the device should always be treated with the appropriate care for an optical measurement instrument. Please refer to section 1.2 for details.

3 First Use

3.1 Unpacking and Scope of Delivery

Your TLC Explorer is built and inspected according to the relevant guidelines and norms for electronic instruments (for details see section 12). It left the factory in a safety-tested and technically perfect condition. In case you notice any damage to the packaging that could have impacted the device, document these and contact your supplier. Do not operate the TLC Explorer, if you suspect any of the criteria listed in section 1.2.1 to apply.

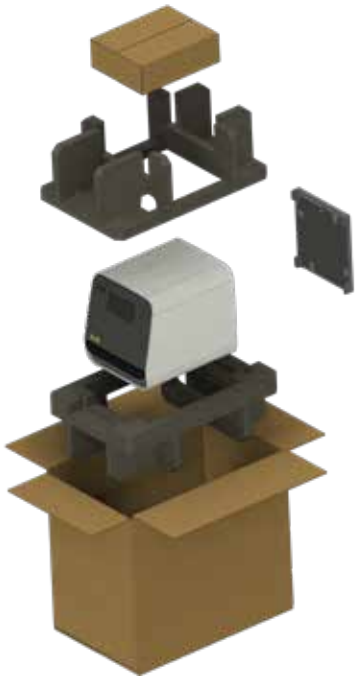


Figure 3.1: Packaging overview

It is strongly recommended to retain the packaging material for later transport and/or storage of the device, especially for warranty claims.
After opening the cardboard box, first take out all accessories, including the Baseplate, and the upper protective carton. Ensure all loose parts are removed before proceeding. Turn the box, so that the glass front is facing you, and prepare a suitable space to place the device, for when you have taken it out of the box. Only then lift the TLC Explorer (which has a weight of about 10 kg) by holding it on the bottom under both sides. Remove all transportation fixtures – like the adhesive tape fixing the drawer – and protective foils.

Verify that your delivery includes all the following:

- One TLC Explorer with installed illumination unit (to check illumination unit, see section 3.3 below)
- One Baseplate
- One WiFi antenna
- One USB-C power adapter with eight power cables for different socket types
- One dust cover
- Two stickers with two QR codes – used to connect to the device more easily (see figure 3.2)
- One brochure with the title “TLC Explorer Documentation System – Getting started” and SAFETY ADDENDUM

3.2 Setting Up for Safe Operation

Please carefully read section 1.2.2 about installation requirements before selecting a suitable location for your device. Check that the drawer **F5** can be completely opened, the Baseplate inserted, and TLC plates be seen through the inspection window **F7** in a safe, convenient, and ergonomic way for all planned users. Especially consider different body heights and possibly disruptive light reflections on the device's glass front.
Keep an easily accessible copy of this operational user guide near the TLC Explorer, e.g. as a digital document on the tablet or desktop computer you plan to use to control the device.

3.3 Powering Up and a 'First Look' on Your Plate

Choose a power cord **A3** that fits the power outlet, connect it to both the power adapter **A2** and the power grid, and then plug the USB-C connector into the port **B1**. On the front side, you should see the power icon **F1** light up. Gently hold a finger on the power icon for about two seconds, until the icon begins to flash, indicating that the device is booting. After about 30 seconds the icon stops flashing, shines brighter, and the device is ready to operate.
Open the drawer **F5** and insert the Baseplate. The side with the wide edge and embossed emblem should be facing outward, i.e. be next to the drawer handle. Verify that the alignment pin **P3** has entered the socket **P4**, and that the Baseplate lies flat on the drawer. To close the drawer, push against the middle of the handle until you feel a slight resistance. The drawer is designed to close the last few centimeters on its own. A special damper system takes care to correctly close the drawer without shifting the plates.
Once the red drawer open light **F6** is off, briefly hold your finger against the circle next to the label 'Vis' **F2** to switch on the white light source inside. Pulling down the shutter slider **F8** and looking through the inspection window **F7**, you should see the illuminated Baseplate.
Switch off the light (touching **F2**), open the drawer and place a TLC plate on the plate area **P1**. Close the drawer again and observe the plate through the inspection window under the featured illumination types (touching **F2**, **F3**, or **F4**).
In case your TLC Explorer acts differently than described above, refer to section 9 to identify and resolve the issue before operating the device.

3.4 Connecting Your Laptop

There are different ways to connect various types of user devices (laptops, desktop computer, tablets or even smart phones) to the TLC Explorer, which can be configured according to section 8. A recommended basic approach is to connect your laptop to the TLC Explorer's own WiFi Network. This approach is quickly set up and allows to download images and data you generate with just a few clicks directly to the device you are using.

Figure 3.2: Easily connect by scanning these two QR codes on the label of your device

On a laptop (or desktop PC featuring WiFi) open the network settings and search for a network name (SSID) starting with 'tlc-explorer' followed by the serial number **B6**. Choose 'WPA/WPA2' as the security setting and enter the password shown on the label for Step 1 (see figure 3.2) to establish the connection. It is even simpler to connect tablets or smart phones by scanning the QR code 1 on the sticker provided in the package. You may see a warning that the chosen WiFi has no internet connection – this is correct and by design.
Once the WiFi connection is established, the user interface can be opened in your web browser. Although all common, up-to-date browsers can be used, it is recommended to use Chrome or Firefox for the best user experience.
To open the TLC Explorer user interface, you may either scan the QR code 2 on the sticker, or enter "http://tlc" or the device name instead of 'tlc' in the browser address bar (for details, please see section 8.2).
In case the browser has difficulties to find "http://tlc" (e.g. because the device is connected to the internet via a mobile data network in parallel), you can also enter "http://192.168.200.1" instead. Some browsers enforce encrypted connections and may automatically change the entered address to begin with "https://", to then produce a warning the site may not be secure. The browser cannot know that you are accessing the TLC Explorer in a protected local network, posing far less risk than opening a site from the internet. You may either ignore the warning and proceed, or disable "https-only" in the browser settings, and then manually enter again "http://tlc" in the browser address bar.

You should see a welcome screen similar to the following (see figure 3.3):

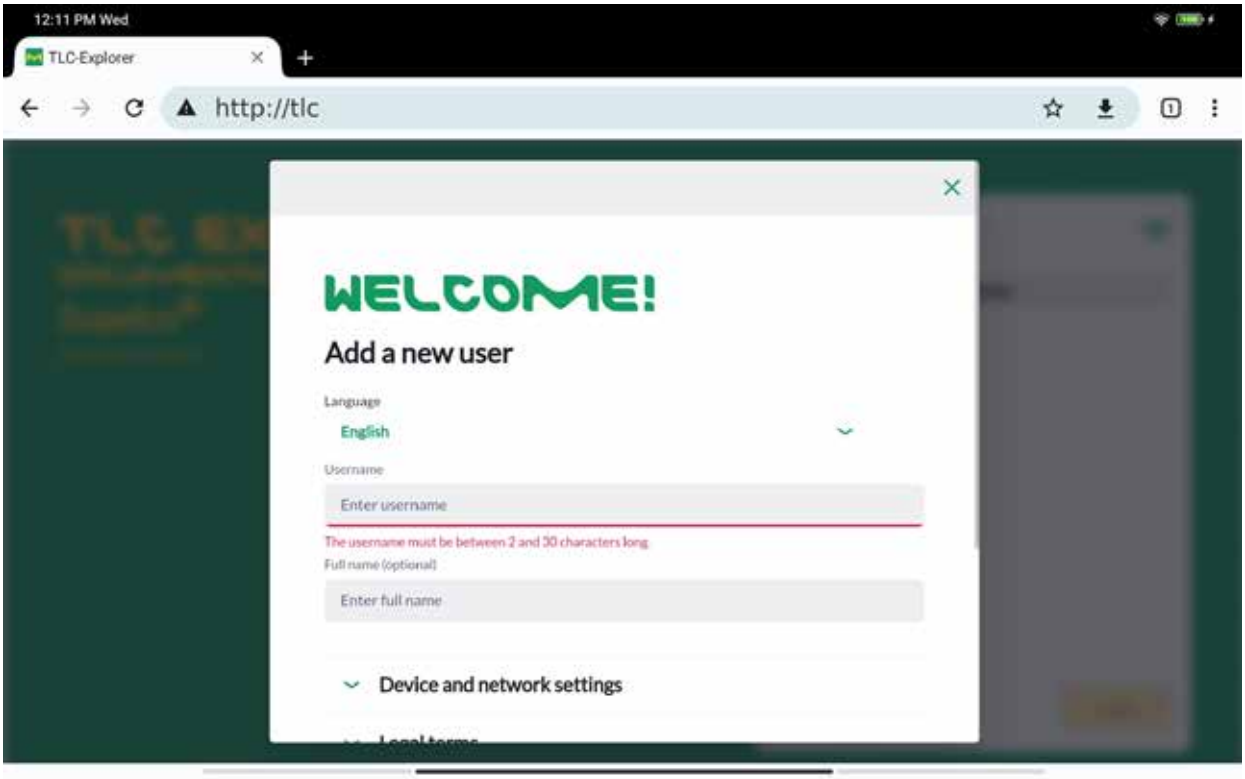


Figure 3.3: First opening of TLC Explorer user interface

Setting a bookmark and/or selecting the menu point 'Add to Home Screen' from the browser menu (often marked as three dots in a column at the upper right browser corner) will significantly simplify opening the site in future.

3.5 Creating a First User

Begin personalizing your TLC Explorer by selecting a language and entering a first username. Since usernames are internally used to name files and directories, not all special characters or symbols are allowed. In case you entered an invalid character, the line under the field will turn red and a warning message will appear underneath.

The full name, which you can enter in the next field, is less restrictive and optional. It may be used to identify the user e.g. as the author of reports.

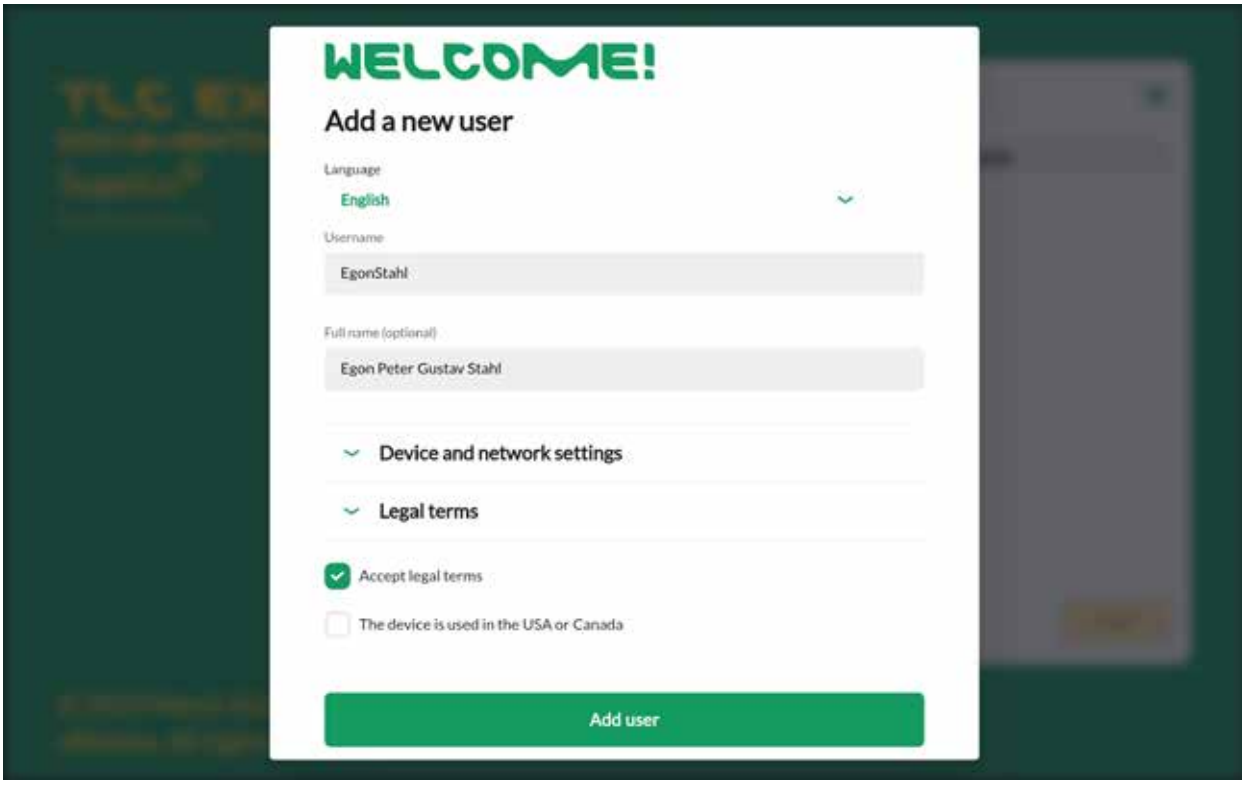


Figure 3.4: Adding a first user

Keep 'Device and Network Settings' for now at their default values. They can be modified any time later at the 'Settings' page.
Expand and carefully read the legal terms before clicking in the box to the left of 'Accept Legal Terms'. Your agreement to these terms is needed for you to operate the instrument and software. In case your device is located in the US or Canada, you are required to check the respective box.

After you have clicked on 'Add User', the initial setup is complete and the device ready to be used.

You will be automatically forwarded to the standard welcome screen seen at figure 3.5. Select the user you created and click 'Login' to start capturing images of your TLC plates.

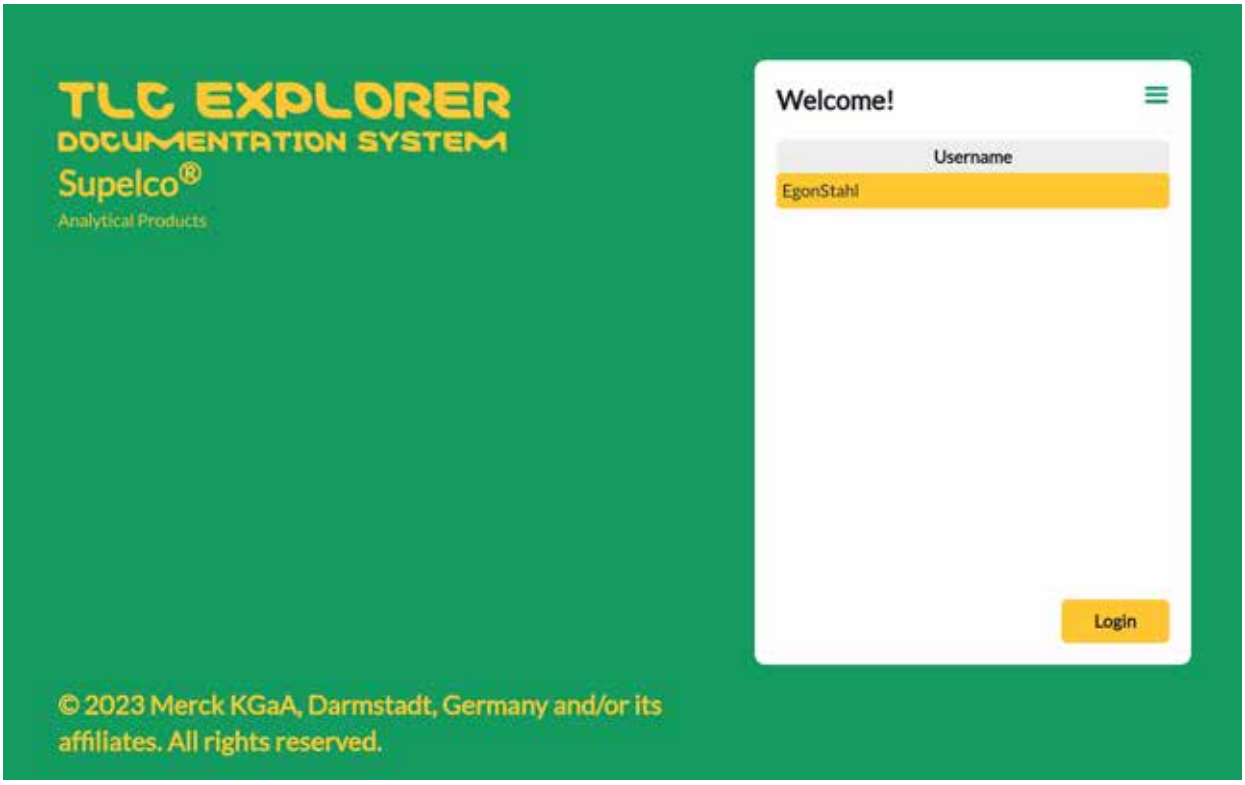


Figure 3.5: Welcome screen with user selection

3.6 Powering Down

Like any desktop computer, the TLC Explorer needs to be properly shut down before unplugging the power supply. Failing to do so may damage the device.
In order to shut down the device correctly, click on the main menu icon (three horizontal bars in the upper right corner), and select 'Shutdown' from the menu that appears. From the dialog depicted in figure 3.6 you may choose to shut down the device, restart (i.e. reboot) the device, or just restart the software application. You may also touch the power icon **F1** for about 2 seconds, but would need to confirm the shutdown at the user interface (the previously mentioned dialog will appear automatically on all active user sessions).
If you choose to restart the device or application, just wait for about a minute until the welcome screen shown in figure 3.5 reappears, and the device is ready again.

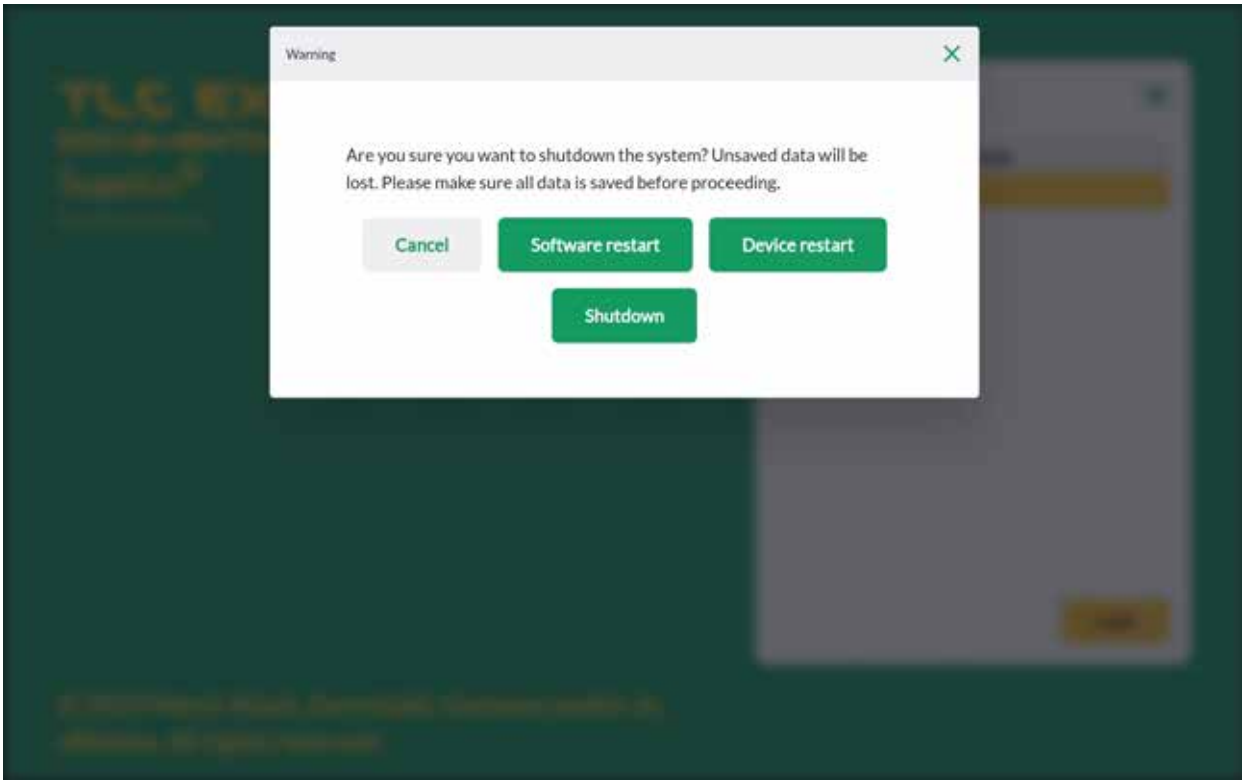


Figure 3.6: Shut down or restart device

Keep 'Device and Network Settings' for now at their default values. They can be modified any time later at the 'Settings' page.
Expand and carefully read the legal terms before clicking in the box to the left of 'Accept Legal Terms'. Your agreement to these terms is needed for you to operate the instrument and software. In case your device is located in the US or Canada, you are required to check the respective box. After you have clicked on 'Add User', the initial setup is complete and the device ready to be used.

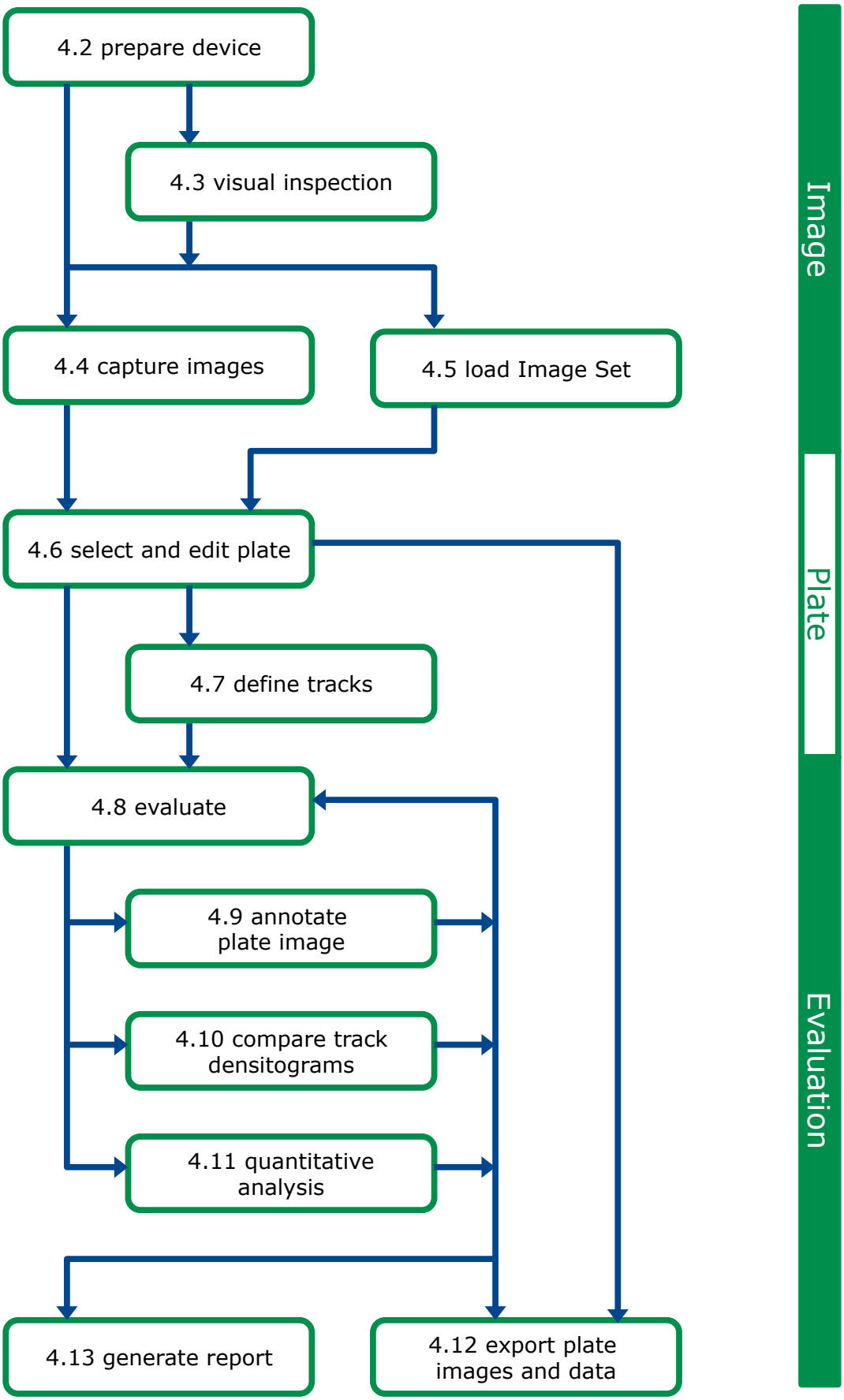
4 Operational Guide

4.1 Typical Workflow

Whether you just want to take a quick look at a TLC plate, capture and export an image of a plate (maybe with some annotations) for some document, or need a quantitative analysis with a complete report – the TLC Explorer lets you do just that.
Consequently, there is no single process to follow, but different tools you can choose and combine to process your data according to your needs. You may even evaluate the same TLC plate in multiple ways, e.g. to investigate different research questions.
The following chart (figure 4.2) gives you an overview of the different documentation and Evaluation steps. To find more details on any of these steps, please refer to the respective section of this section (as indicated by the indices to the left).
To the right of figure 4.2 you will note a bar with 'Image', 'Plate' and 'Evaluation'. These correspond to the progress bar at the top of the software user interface (see figure 4.1) and structure processing steps on 3 pages:

- 'Image': Capture new image or load an existing Image Set.
- 'Plate': Name each plate of an Image Set, add information and define tracks.
- 'Evaluation': Annotate plate images, plot and compare track densitograms, or perform quantitative analysis.

Figure 4.1: Progress bar with main steps and main menu in upper right corner (click on 3 bars)


4.2 prepare device
4.3 visual inspection
4.4 capture images
4.5 load Image Set
4.6 select and edit plate
4.7 define tracks
4.8 evaluate
4.9 annotate plate image
4.10 compare track densitograms
4.11 quantitative analysis
4.13 generate report
4.12 export plate images and data
Image
Plate
Evaluation

4.1.1 Main Menu

The main menu can be opened by clicking the 3 horizontal bars in the upper right corner. It provides access to functionalities that have no single place in the workflow. Except for the welcome screen, where it only offers 'Settings' and 'Shutdown', it features on all pages the options displayed in figure 4.3 . Please refer to the sections listed to the right of these options for more details.

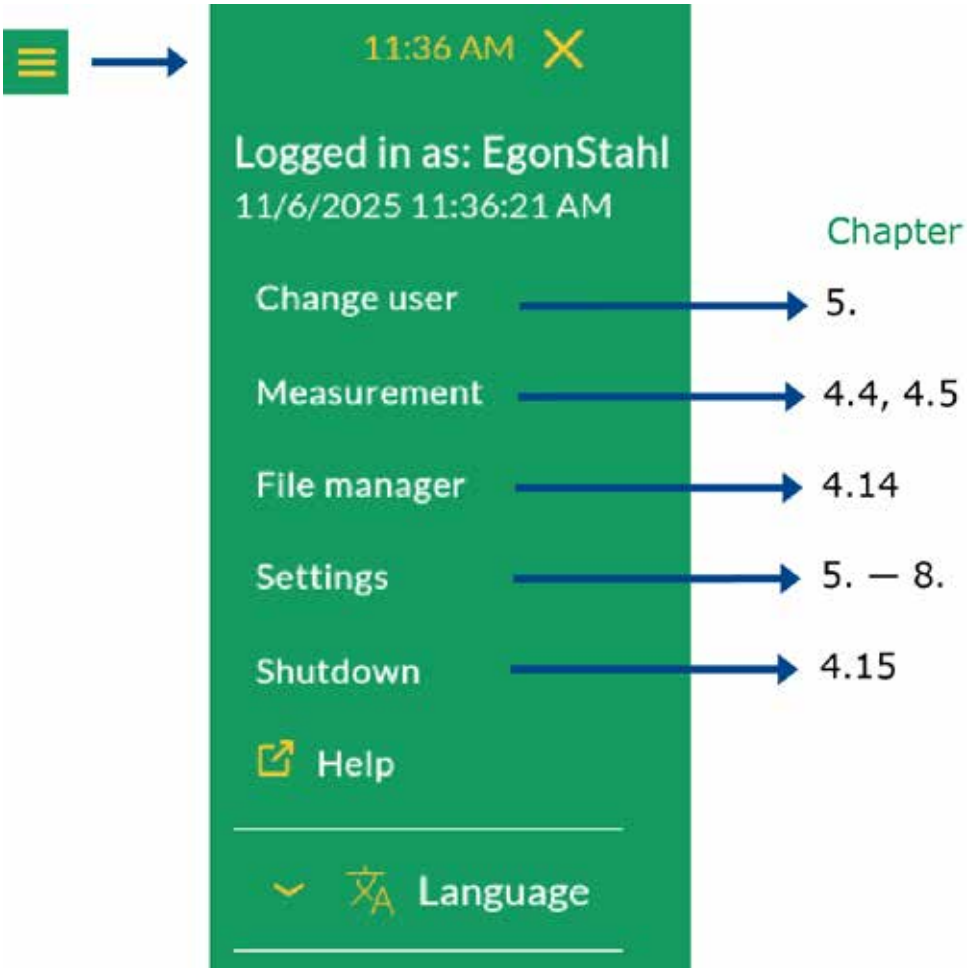


Figure 4.3: Main menu with the related sections in this manual

4.2 Device Preparation

After connecting the TLC Explorer to the power grid (or power bank), a dim white light under the power icon **F1** shows that the device is ready to boot. Place you finger on the icon for about 2 seconds and allow the instrument some 30 seconds – while the icon is flashing – to get ready for operation.
Place a TLC plate on the Baseplate and close the drawer **F5**. Once the red open drawer indicator **F6** turns off, you will note a brief white flash of the circle next to 'Vis' **F2** – the system has just taken a snapshot to show a preview of your plate in the software.

4.3 Visual Inspection

Prerequisites:

- The TLC reader is on; the power icon **F1** is lit up brightly (not flashing nor dimmed).
- The drawer is closed correctly and the red open drawer indicator **F6** is off.
- No user is capturing images at the same time (see also section 4.4).

Select the illumination type you would like to use by briefly holding your finger on the respective button (**F2**, **F3**, or **F4**) until the circle lights up. Then gently push down the shutter slider **F8** to open the inspection window **F7**. Depending on your observation angle, you can push the shutter slider fully or only partly down to see the relevant part of the TLC plate.
You can switch to another illumination type by touching the respective button or turn off the illumination by pressing the same button again.

4.4 Image Capture

Prerequisites:

- The TLC reader is on; the power icon **F1** is lit up brightly (not flashing nor dimmed).
- Drawer and inspection window are closed correctly, and the red open drawer indicator **F6** is off.
- One or more TLC plates with a minimum size of 2.5 x 7.5 cm and a maximum size of 20 x 20 cm lie flat on the plate area **P1**.
- Only one user at a time can capture images. While other users may load and process Image Sets in parallel, competing attempts to capture images will cause error messages.

Assuming you have connected a tablet or mobile phone as recommended in section 3.4, you can just click on the desktop icon, or bookmark you saved in your browser, to open the welcome screen seen in figure 3.5. Select your username and click on ‘Login’.

The page that opens after each login (see figure 4.4) lets you either capture new images or load an existing Image Set (see section 4.5). At the left – or, for small screen width, on the top – you will see the low-resolution image of the Baseplate that was captured when you closed the drawer. You can refresh it by simply clicking the image.

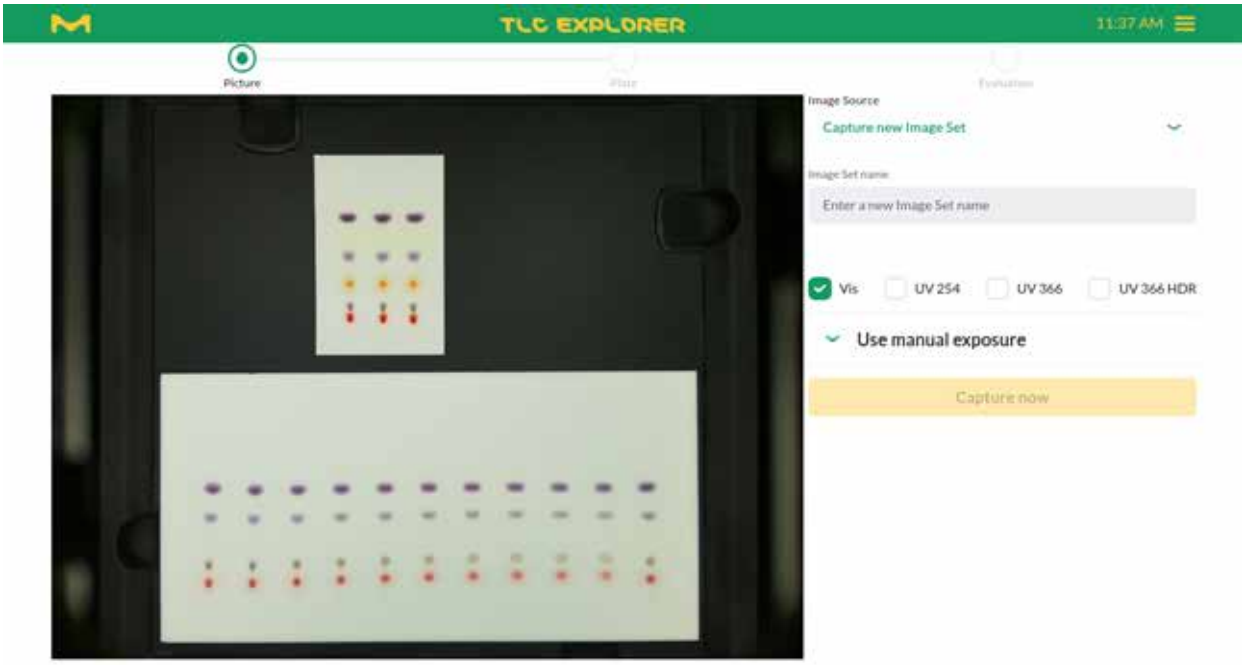


Figure 4.4: Capture images or load existing Image Set

Select the option 'Capture new Image Set' from the drop-down menu and enter a name for the new Image Set in the text field. Because this name will be used as part of image filenames, not all characters are allowed. Furthermore, the name needs to differ from other Image Set names stored for the user. In case an Image Set name is invalid, the software informs you about the reasons.
Checkboxes let you choose which illumination types you wish to use for the image capture. Please note, that 'VIS' (white light) is activated by default; it can be deselected after another illumination has been chosen.
Expanding the 'Use manual Exposure' section allows you to set the exposure time in milliseconds for each of the chosen illumination types (see figure 4.5). Click on the camera icon to let the system take a low-resolution image with the selected exposure time and shows it as a preview. With the 'Auto' button, you request the system to take a series of images and determine automatically the optimal exposure time for your plate. Please be aware that this process might take several seconds, and only proceed when you see the preview updated.
With a click on 'Capture Now', the instrument starts capturing images. You can see, which image is currently being taken, both in the text above the progress bar and on the respective illumination button (**F2** - **F4**) on the device lighting up.

The resulting images of all illumination types are stored together as an 'Image Set'. The system then searches for plates in the images. As soon as all plates are detected, rotated (aligning their bottom edges horizontally), and extracted as separate images for further processing, the user is automatically forwarded to the next step for plate editing (see figure 4.6).

In case you only intend to use the captured images (or the extracted plate images), you can bypass all further processing by using the file manager to download the images you have just taken (for details see section 4.14.1). Alternatively, you can simply click the 'Download image' button at the bottom of the 'Plate' page to save the image currently shown in the preview area. The Image Set can still be loaded and processed any time later on.

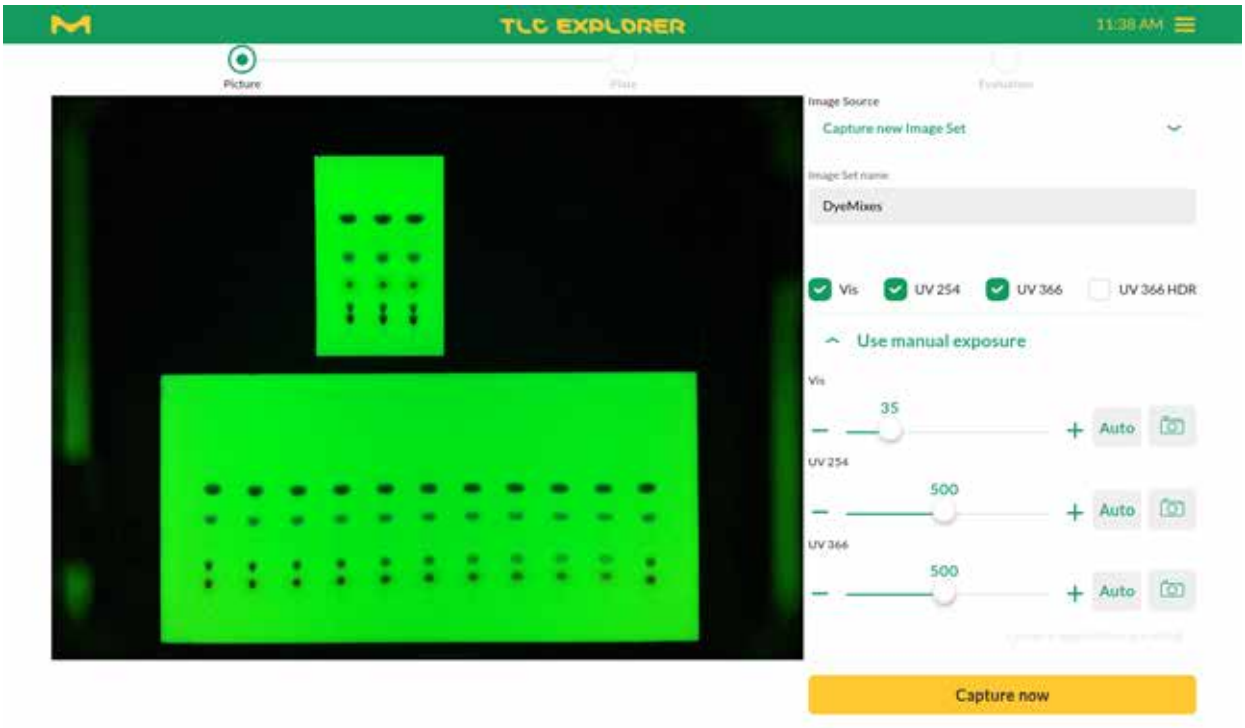


Figure 4.5: Manually set exposure time for selected illumination types.

4.5 Loading an Existing Image Set

Prerequisites:

- You have previously captured, imported or copied an Image Set (see section 4.14.2).

To open and process previously saved Image Sets, select 'Load Image Set' from the 'Image source' drop-down menu and then click on the – initially blank – 'Select an Image Set' drop-down. A drop-down menu appears which allows you to preview the images in the set individually, or all together, as depicted in figure 4.6.
Confirm your choice by clicking 'Use Image Set'. The system will automatically forward you to the next step for plate editing (see section 4.6).
Users can only open their own Image Sets. To work with an Image Set that belongs to a different user, you need to create your own copy in the file manager (see also section 4.14.2).

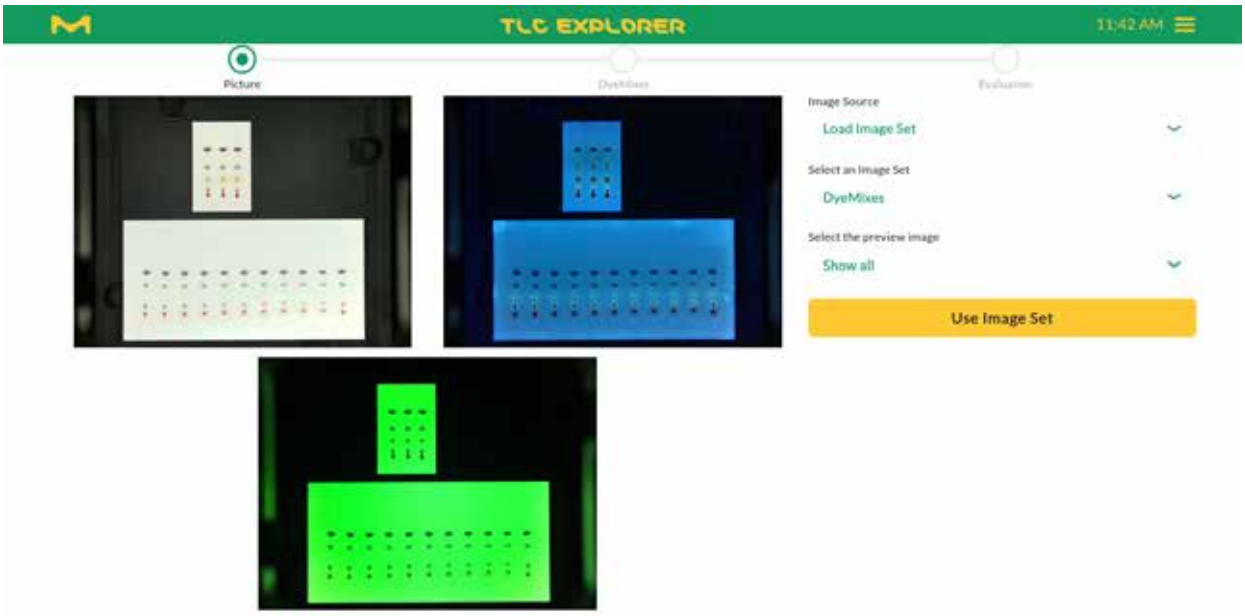


Figure 4.6: Preview and open an existing Image Set

4.6 Select and Edit Plate

Prerequisites:

- You have captured or loaded an Image Set.
- At least one plate was found.

Each plate found in the Image Set can be named and edited individually before evaluating the tracks. You can optionally add information about the plate and modify track properties, building the base for further analysis.
In the preview area to the left (see figure 4.7) – or, for small screen width: on the top – the plate is already aligned and cropped (with a small margin), with boxes automatically drawn around detected tracks.
In case you placed multiple plates on the Baseplate, you can click on 'Show Overview' to see all plates with their indices, and then select the one you would like to edit from the drop-down menu at the top. You may also change the numbering order of plates by clicking at the three bars to the right of this drop-down menu. Especially when there are several plates in an Image Set, it is recommended to give each one a unique name using the input field labeled 'Rename'.

You can use the buttons +90° and -90° to rotate the plate image. Rotating the plate image will also delete all tracks and replace them with those automatically detected in the new orientation. You can use this function to reset the track search, e.g. because the track width on your plate differs from the default value. If required, expand the 'Tracks' section, set a suitable track width and then rotate the plate back and forth for a new automatic track detection.

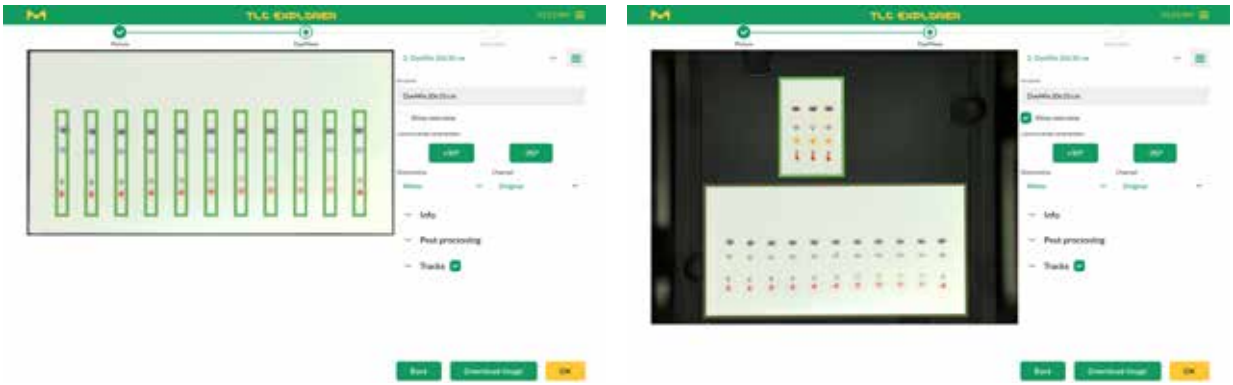


Figure 4.7: Selecting plate for editing

Below the buttons for plate rotation you will find two drop-down menus labeled 'Illumination' and 'Channel', which you will also encounter at other processing steps. For each illumination type chosen for image capture (see section 4.4), the device creates a separate 8-bit RGB image (i.e. it saves the intensity of red, green and blue light to build a color image). 'Illumination' thus lets you select a specific plate image, e.g. white light ('Vis') or UV-A ('UV366'). From this image, you may then select a specific channel, namely

- 'Original', meaning RGB color image,
- 'Intensity', the image transformed to gray level,
- 'Red', the intensity in the red channel only
- 'Green', the intensity in the green channel only, or
- 'Blue', the intensity in the blue channel only.

To improve the visibility of low-contrast single channel views with pseudo colors, activate the 'Heatmap' checkbox to the right of the 'Channel' drop-down menu.

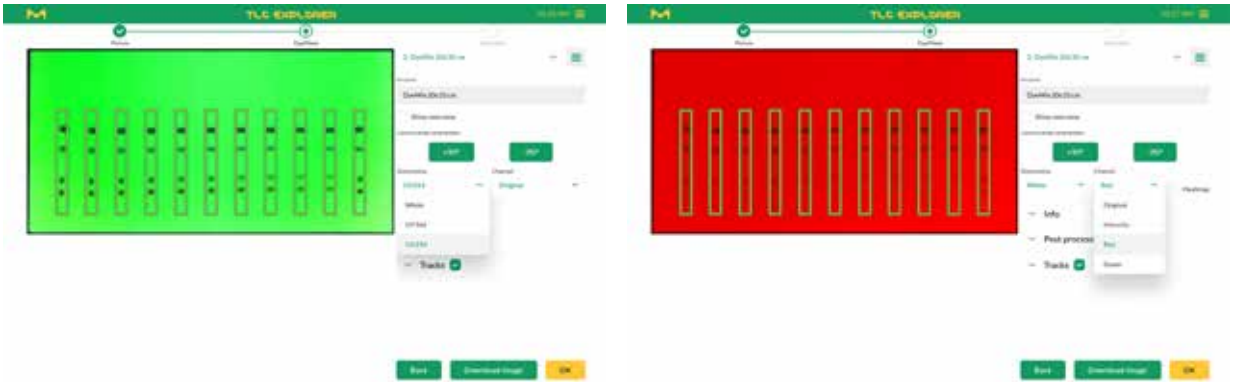


Figure 4.8: Choose illumination and channel

For later reference and, if desired, for report generation, the 'Info' section allows the entry of optional details about the plate and its preparation before the image capture. These include information about the plate type, solvent and staining used for the analysis, as well as notes and comments that you would like to store with the plate data.
Plate images can also be edited to reduce image noise or enhance contrast (see figure 4.9). To protect original data from being overwritten, the modified image needs to be saved separately by entering a name under 'New processing name' and clicking on the button to its right. It will then be selectable at all future steps for processing from the 'Illumination' drop-down menu. Please note that the algorithms for 'Quick clean' and 'Sensitive clean' are designed to remove typical impurities and contamination in images captured under UV-A illumination at 366 nm and may generate artifacts.

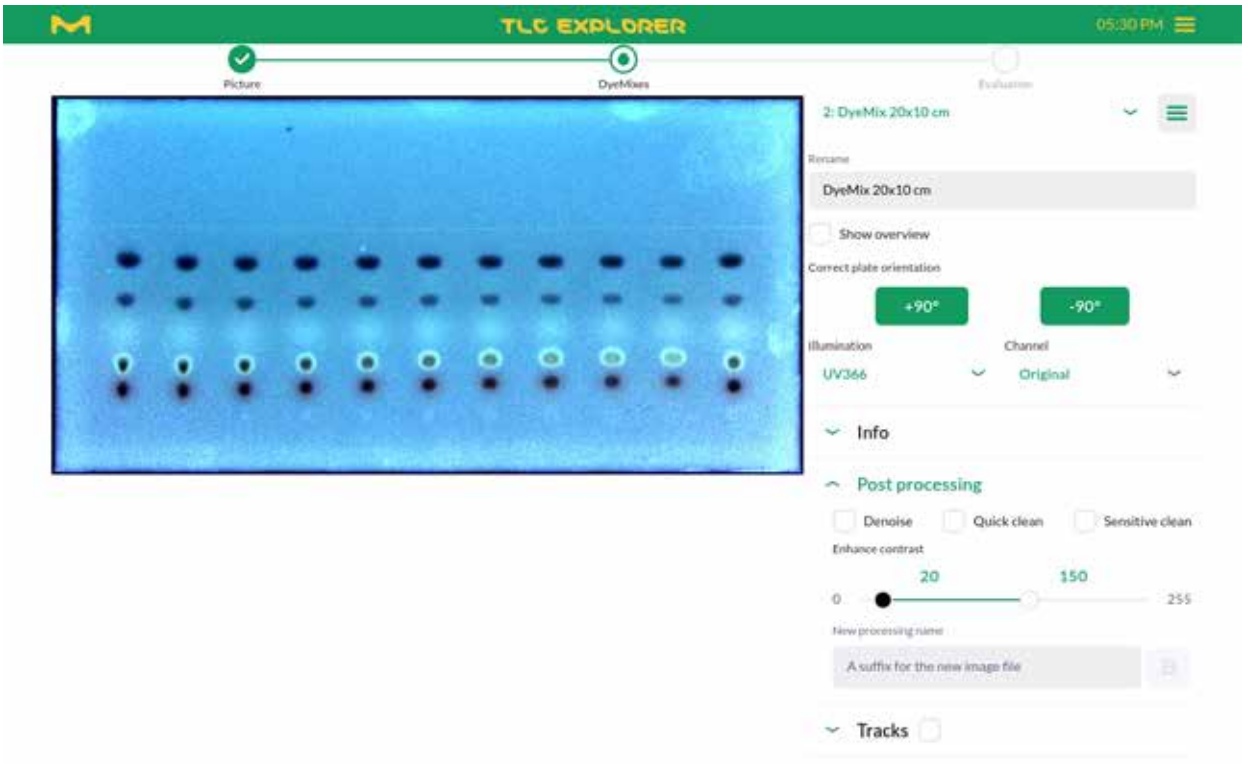


Figure 4.9: Image post processing, used here for instance to make the solvent front visible

4.7 Define Tracks

Prerequisites:

- You are on the 'Plate' page (see progress bar at top).
- The plate is oriented correctly (rotating the plate will reset changes you made on tracks).

This step allows you to add, remove, shift and name tracks. Track definitions will be used for new Evaluations started at the next step. If necessary, you can come back later on, edit tracks and then create a new Evaluation with the modified track properties. However, to ensure data integrity, any changes made to tracks do not affect existing Evaluations.
Under the heading 'Tracks' you find sliders to adjust the position of baseline, solvent front and track width for all tracks of that plate. You also can set the concentration unit – by default 'µg/µl' – to be used at the evaluation and report generation later on.
Automatic track detection takes into account all captured images – to also detect substances that are only visible under UV illumination – but might not always find all tracks correctly. If you note that the default track width does not match those on your plate, please adjust the slider labeled 'Track Width' and then rotate the plate back and forth for a new automatic track detection.
Falsely detected tracks can be easily deleted by clicking on the trash icon in the specific track's row.

Adding tracks can be done in two ways: After clicking on 'Add Track', you can either

- enter the track position in millimeters from the left plate edge and confirm with 'Done', or
- click directly on the track in the preview image.

In both cases confirm again with 'Done' after all desired tracks have been added.

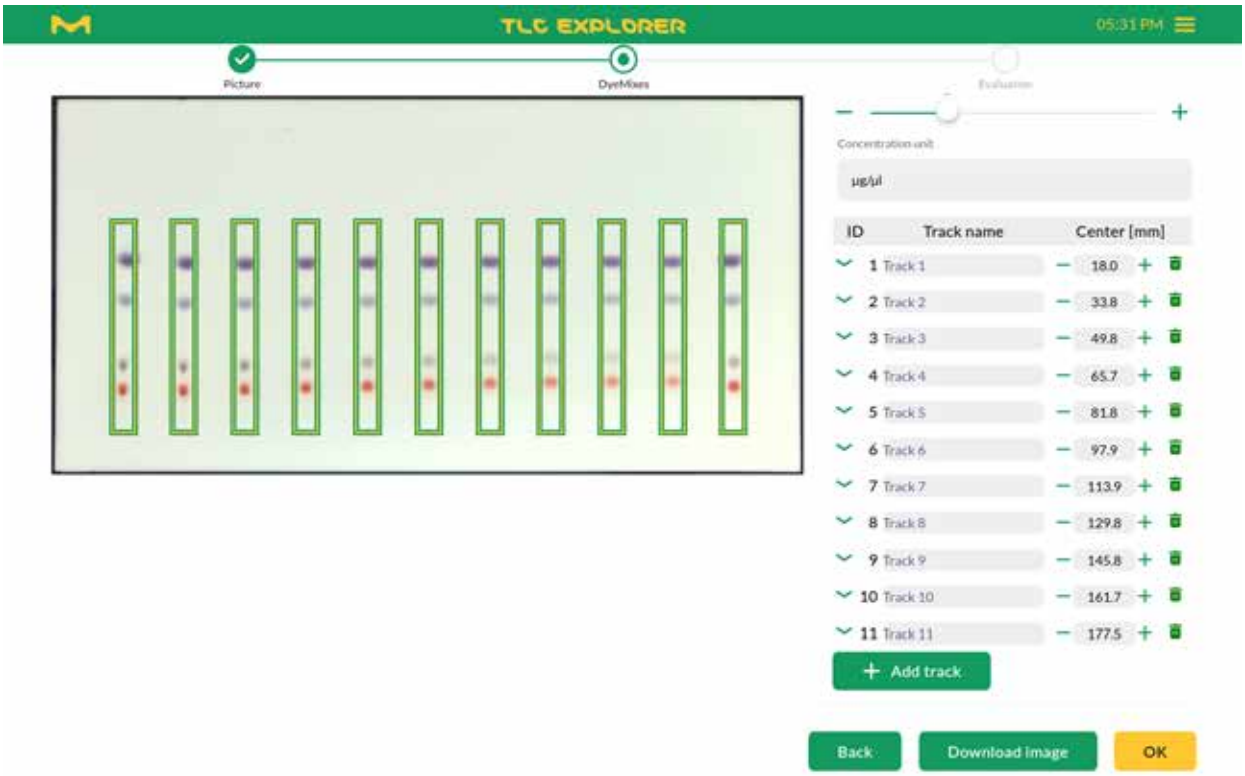


Figure 4.10: Adding and removing tracks

You can also shift each track by changing its value for 'Center' (again, in millimeters from the left plate edge) and give it a unique name.
For maximal flexibility, the baseline (start line) and solvent front can be set for all tracks together and be finetuned for each track individually. Typically, the sliders would be used to optimally align the baseline and solvent front position for the central tracks (see figure 4.11). Assuming the solvent front runs lower on the plate edges, the first track could be finetuned by clicking the arrow to the left of the respective row. After the checkbox in front of 'Solvent front' has been unchecked, the appropriate value for this specific track can be set. To apply again the general solvent front for this track, just click once more on the checkbox.
The table's extended track view (opened and closed by clicking on the arrow), also lets you add an explanatory note or comment to each track, record the applied sample volume in µl and mark the track as reference with a given concentration for quantitative analysis later on.
Depending on your preferred workflow, you may also change baseline, solvent front, sample volume and reference properties later on for a selected Evaluation.
Clicking the 'Back' button brings you back to the 'Image' page for capturing or loading Image Sets. Please note that this does not undo or reverse the settings you made on the 'Plate' page. The 'OK' button, in turn, forwards you to the 'Evaluation' page (all tracks relevant to your Evaluation should be defined beforehand).

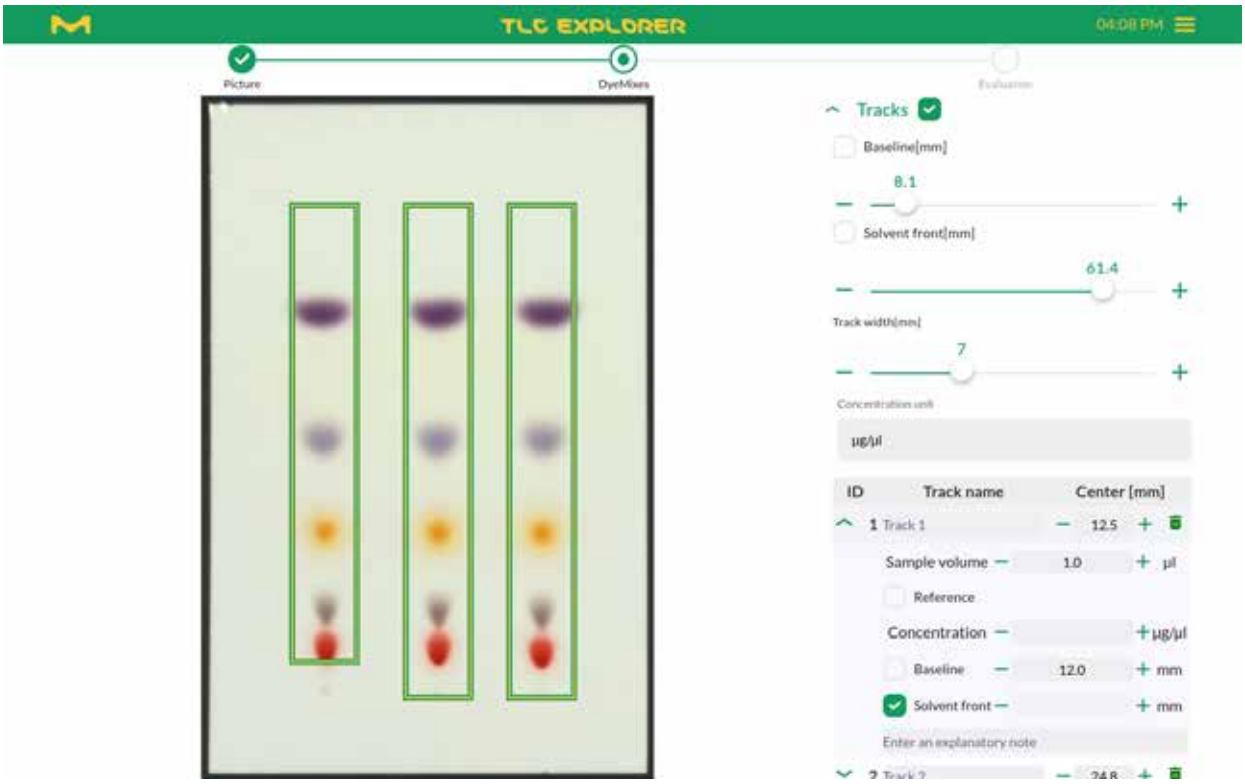


Figure 4.11: Adjusting baseline and solvent front for all tracks and fine tune individual tracks

4.8 Creating an Evaluation

Prerequisites:

- You are on the 'Evaluation' page.
- Before creating a new Evaluation, check that all plates used for the Evaluation have all relevant tracks defined.

Whenever a new Evaluation is created, the system copies all current plate images and settings from the plate editing section (see sections 4.6 and 4.7) into a separate directory. Later changes will only affect Evaluations created afterwards if you click on the 'Create new Evaluation' button (see figure 4.12).

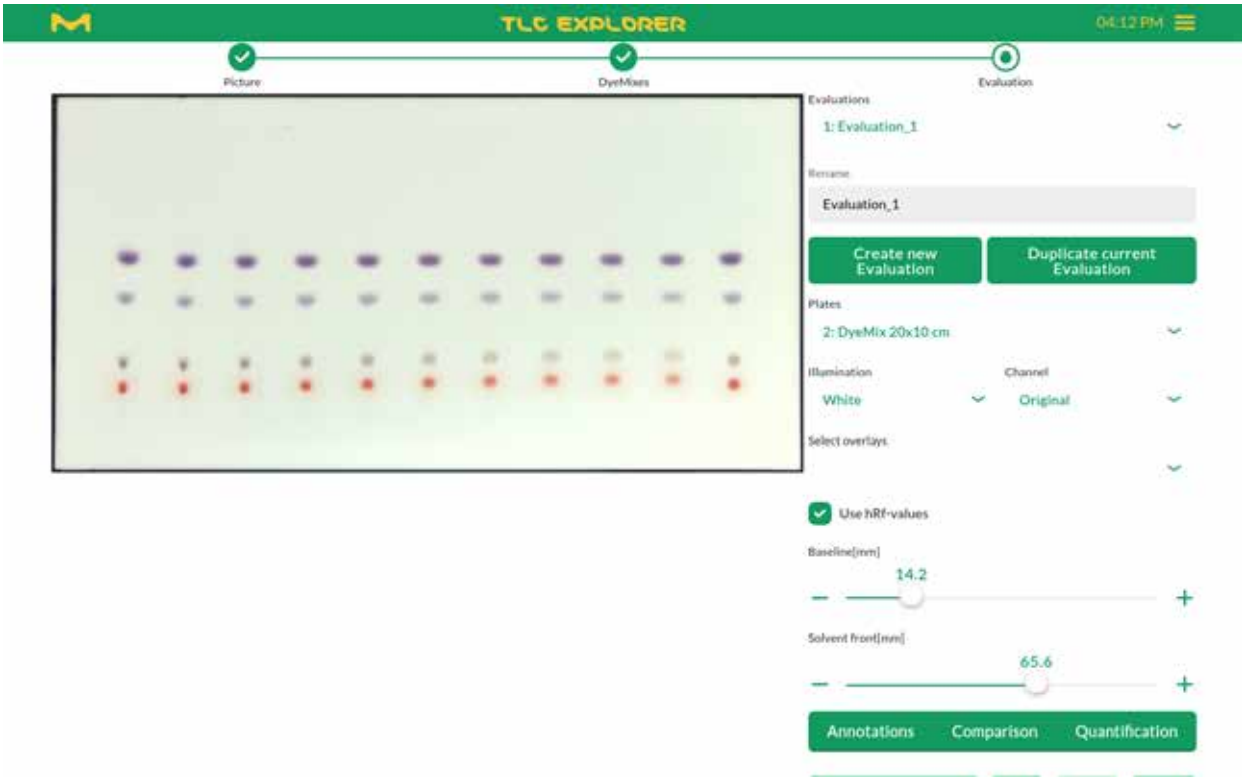


Figure 4.12: Creating new Evaluations

Pressing 'Ok' at the bottom of the plate section automatically creates an Evaluation named 'Evaluation_1'. Just like with plates, you can give it a unique name in the text field labeled 'Rename'.
It is also possible to create a new Evaluation based on an existing one. After selecting the Evaluation you would like to copy from the drop-down menu at the top of the section, you can simply click on 'Duplicate current Evaluation'. Changes on either of these Evaluations will not affect the other one.

At any time during the Evaluation process, you can configure the preview area according to your needs (see figure 4.13). You can choose a plate, the plate image ('illumination') and a specific channel from this image (for details see section 4.6) that you would like to see. Furthermore, you can activate or deactivate the display of

- the solvent front,
- the baseline,
- annotations (see section 4.9),
- a R_f scale, going from 0 at baseline to 1 or 100 at solvent front (the latter if 'Use hRf-values' is checked),
- a centimeter scale around the plate (for example see figure 4.13), and
- bounding boxes of all track areas.

Two sliders allow you to adjust baseline and solvent front positions for the active Evaluation. The bottom of the section, you will find buttons labeled 'Capture/Load Image' and 'Plate' that let you navigate back to the respective page (alternatively, you can click in the progress bar on the top of the page).

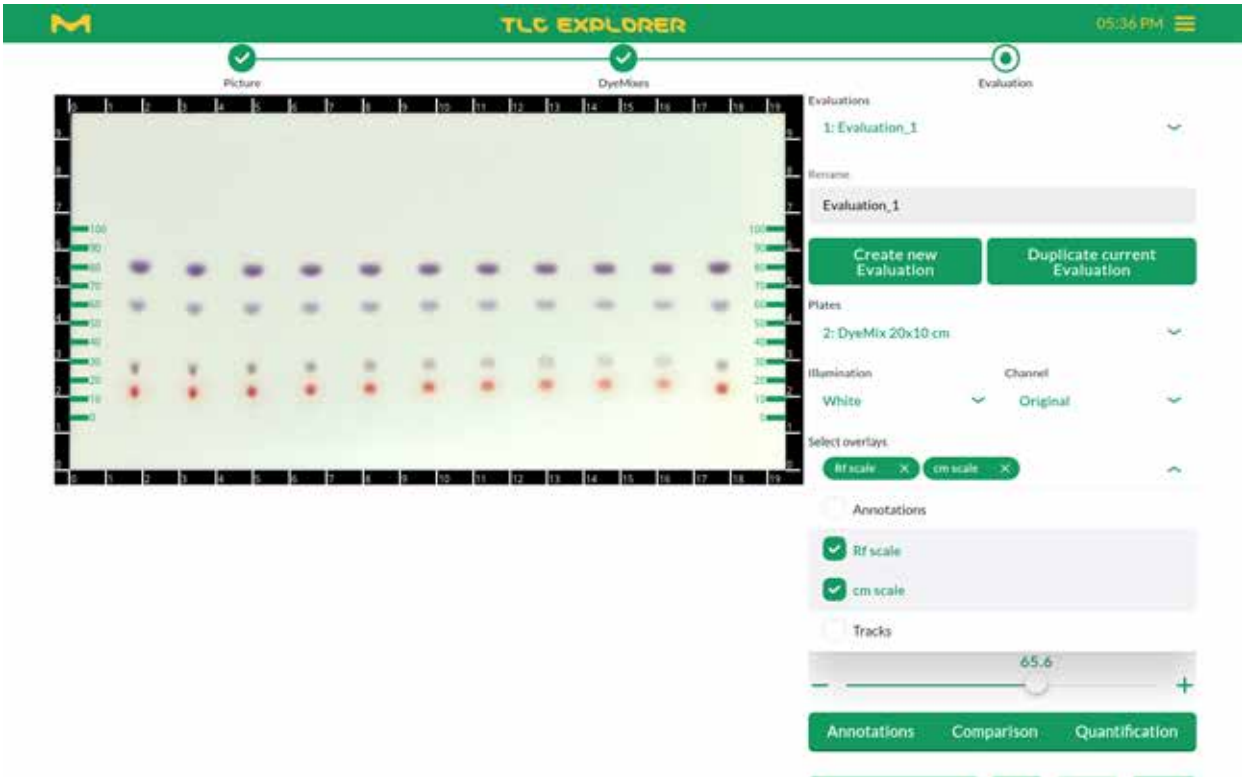


Figure 4.13: Configuring the preview area for Evaluation work

4.9 Annotate Plate Image

Prerequisites:

- You are on the 'Evaluation' page.
- Annotations are part of an Evaluation. If you would like to edit annotations later on, make sure to have selected the corresponding Evaluation from the drop-down menu at the top of the section.

You can mark points and add comments anywhere on the plate. Click 'Annotations' in the Evaluation section and then '+ Add Annotations' to activate the feature. Then just click on the locations in the plate preview you would like to comment on.

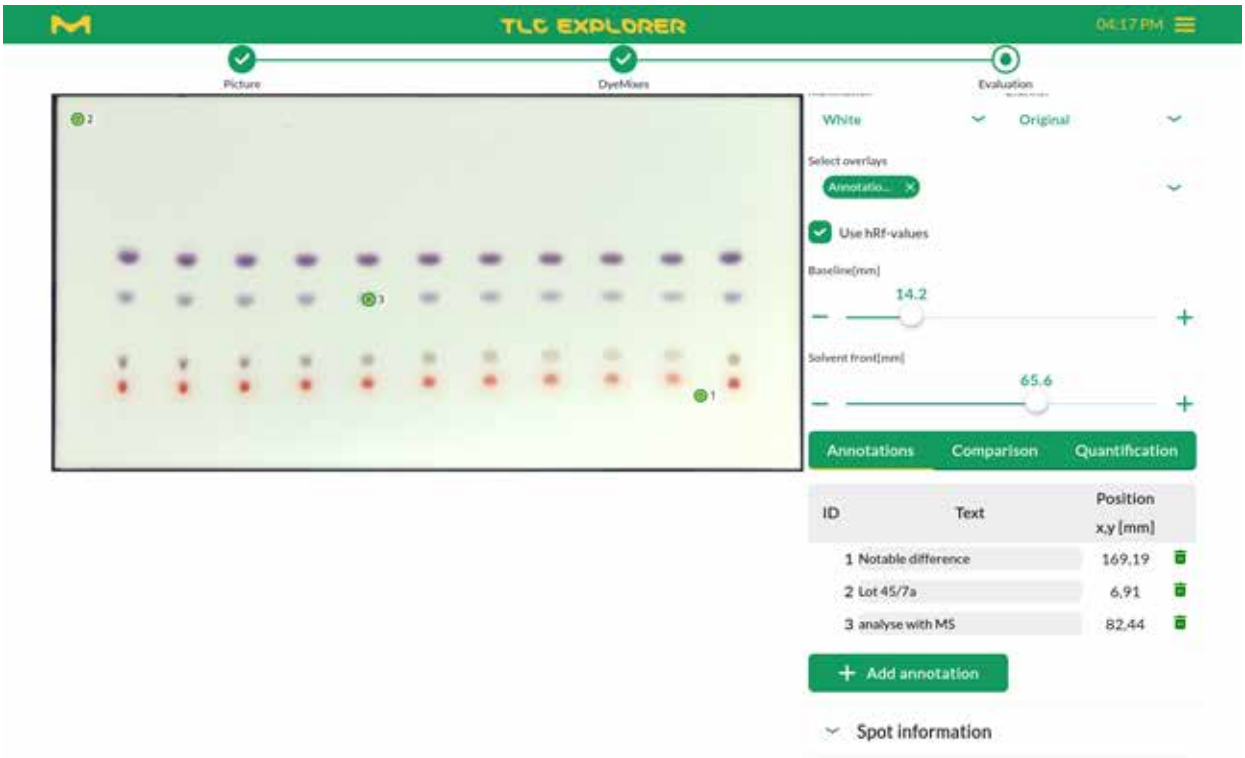


Figure 4.14: Adding annotations

In the upper table, directly under the 'Annotation' tab, you will see a row for each point you added (see figure 4.14). They were given their index in the order added. This order can easily be changed, however, by touching (or left-clicking with a mouse) and holding a row to shift it up or down in the table. In the same table you can also add text to an annotation, or delete it.
While annotation texts are not shown in the preview, these texts can be written into plate images next to their corresponding point by pressing 'Export', and then selecting 'Export images as displayed' in the dialog, before clicking 'Download Export'. In the downloaded zip-file, all images with annotations are marked with the suffix '_overlay.jpg'.

You may want to analyze relevant plate locations later on with other instruments as, e.g. mass spectrometry. For such applications, annotation locations are also listed in millimeters from the lower left plate corner (see drop-down menu under 'Position' column header). These can also be exported as a CSV file (marked with the suffix '_Annotations.csv') to simplify entering selected plate locations at the next device. More information about exporting images and data can be found in section 4.12.
You will see a second table under the one just discussed. This second table lists spots marked as part of the 'Comparison' Evaluation step (see section 4.10) and are listed here merely as information. To distinguish spot markings from user annotations in the preview, look for a ":" – spot markings are formatted as <track index>:<spot index>, while freely placed annotations are displayed as just one number (their index).

4.10 Plot and Compare Track Densitograms

Prerequisites:

- You are on the 'Evaluation' page.
- Before creating the Evaluation, all relevant tracks were defined on the plate page (see section 4.7).

Tools under the 'Comparison' tab allow you to plot and compare densitograms of tracks. Densitograms are calculated for a specific channel of a selected plate image (for details see section 4.6) as the mean or median intensity pixel values over the track width. If needed, you can fine tune parameters like smoothing, or the line color, and add annotations to spots. You can then save the plot as an image to include it in a document, or export the data to process the densitogram further with other tools.

4.10.1 Plotting Densitograms

To illustrate the key features available under 'Comparison', have a look at the following step-by-step example:

1) Select a plate from the drop-down menu below the 'Create new Evaluation' button.
2) Click on the 'Comparison' tab.
3) Use the slider to adjust the track width.
4) Click the '+ Add Track' button at the end of the upper table.
5) Select a track by either clicking on it in the plate image or choosing it from the drop-down menu 'Select a track' in the upper table.
6) At the upper table, select a plate image for the calculation from the 'Select an Illumination' drop-down menu. Please note that this selection is independent from the 'Illumination' drop-down menu further up the page, which sets the preview image.
7) Select the image channel to calculate the densitogram. Choosing 'Original' uses the same base for calculations as 'Intensity', namely transforming RGB values to gray-level values. However, the track under the plot displays in color, not gray.

8) Above the plate image, click on tab 'Densitogram' to see the track plotted. Below it, you can see the vertically rotated track image, scaled to match the plot's x-axis above, and a table with automatically detected peaks (see figure 4.16).
9) To zoom into the plot, just select the region you would like to see enlarged with the left mouse button pressed, or swipe over the region with a finger. The track images below will automatically adapt to show the selected region. Clicking once into the plot adds a ruler with the precise values of all tracks at this RF value, a double click resets the plot to see the full track.
10) Expanding the 'Options' section gives you access to additional controls (see figure 4.16) which will be applied to all tracks of this 'Comparison':
    - Use either mean or median value of pixels row as densitogram value
    - Smooth the plotting data and set the filter size
    - Automatically detect and subtract the baseline, i.e. the background level of the plate without spots (estimated locally using the blank regions to the left and right of each track).
11) Click on the camera icon in the upper right corner of the plot to save the plot – as it is displayed – in an image file.

For comparison, you can add additional tracks using the same methodology as described above. You may even compare tracks from different plates (please be aware of the limitations of such comparisons) by selecting a different plate as in step 1) of the example above. To better distinguish densitograms, you can click on the line editor in the first column of the upper table to choose a line color and format.
You can also rename a track using the respective text field to the right of the line editor. Please note that this changes the track name for all of the active Evaluation.

4.10.2 Adding Names or Annotations to Spots

Any location along the track and corresponding densitogram can be named (or annotated) using the second table under the 'Comparison' tab. Activated with the '+ Add Spot' button, you can simply click on the spot in the preview image, or manually select a track from the drop-down menu and then edit the hRF value in the table (see figure 4.17). Then just enter a spot name or comment in the text field of the respective row.

Spots listed in this table are marked as annotations in the preview images and the densitogram (if a densitogram for the specific track exists). Like regular annotations, they can be exported to facilitate consecutive processing steps like analyzing single spots with mass spectrometry.

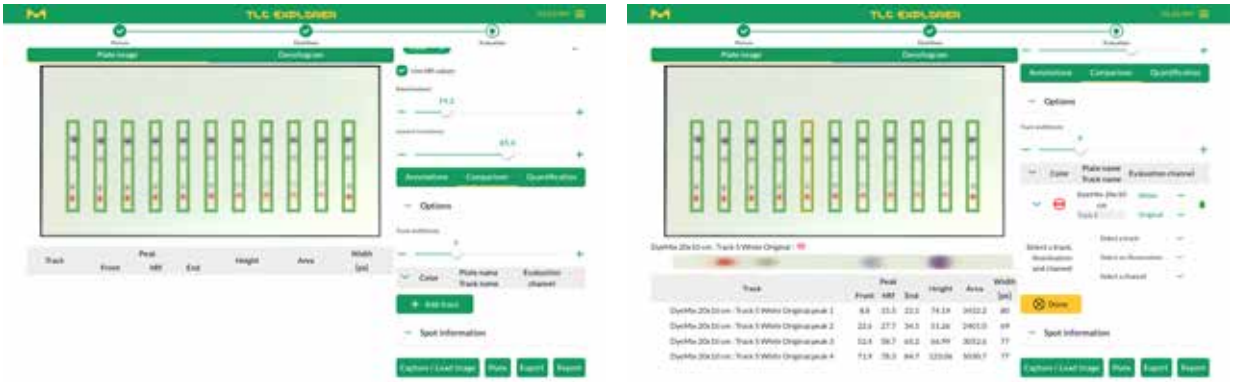


Figure 4.15: Selecting a track for densitogram plotting

Figure 4.16: Edit densitogram calculation and display

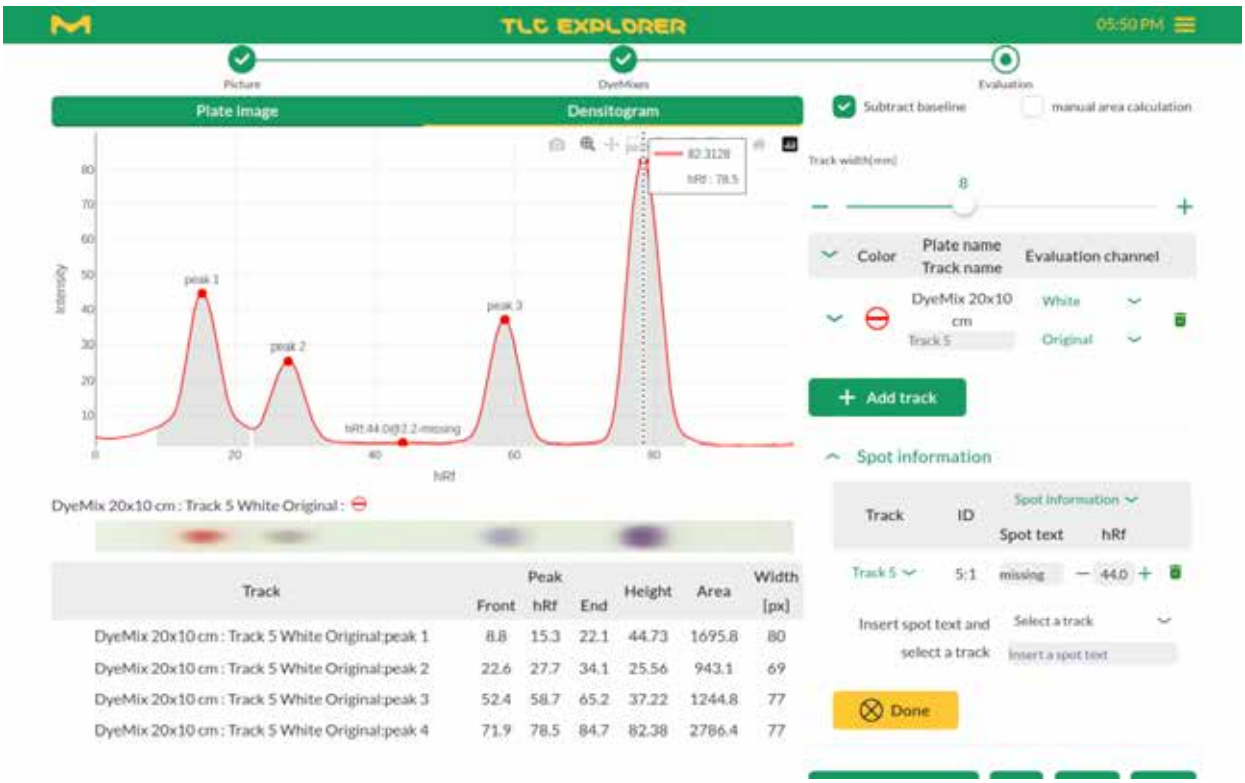


Figure 4.17: Name spots in densitogram and on plate

4.11 Quantitative Analysis

Prerequisites:

- You are on the 'Evaluation' page
- Before creating the Evaluation, all relevant tracks were defined on the plate page (see section 4.7)
- You have at least one reference track for your measurement

To estimate the concentration of a substance, the spot it builds on a track is compared with the corresponding spots of one or more reference tracks, i.e. for which the concentration of that substance is known. Typically, the comparison is based on the height and area of the spot peaks in their densitograms (section 4.10.1 provides details on how densitograms are calculated). Multiple references allow for more accurate estimations using regression methods.

4.11.1 Preparing a Quantitative Evaluation

Quantitative analysis consists of selecting spots, defining some of them as reference, and then optimizing densitogram calculation to provide a good basis for a regression. The following step-by-step example is meant to illustrate one possible approach to use the software efficiently for this task (you might well find a different strategy more suitable for your situation).

1) Select a plate from the drop-down menu under the 'Create new Evaluation' button.
2) Choose the plate image from the 'Illumination' drop-down menu just below the plate selection.
3) To work with the red, green or blue pixel values only, choose these from the 'Channel' drop-down.
4) Click on the 'Quantification' tab.
5) If needed, adjust the track width using the slider.
6) Activate the spot selection by clicking '+ Add Peak'.
7) Select a spot you would like to use for your analysis and zoom in, in the preview image with a pitching gesture on a touchscreen, or the mouse wheel on a desktop computer.
8) Click at the center of that spot; it will be added to the table under the 'Quantification' tab.
9) If needed, adjust the RF values of the peak front and back at the table. In case you don't see the fields 'front' and 'end', open the drop-down of the respective track.
10) Zoom out and click on all other tracks you would like to include in your analysis. The software will recognize the track and automatically set the same peak location as the first one you added.
11) Zoom on each spot (see 7), and, if needed, adjust its peak front and back at the table.
12) If you have not already done so at the 'Plate' page (see section 4.7), define now which tracks serve as reference.
13) Next enter the corresponding concentration and sample volume for each track.
14) Above the preview image, click on the tab 'Densitogram'.

15) Zoom in on the selected spot by swiping with your finger (or a pressed left mouse button) over it, leaving about a third of the peak width as margin on both sides.
16) Expand the 'Options' section under the 'Quantification' tab.
17) Select 'Average' or 'Median' for 'Densitogram Calculation'.
18) Check the box 'Subtract Baseline' to automatically detect and subtract the baseline, i.e. the background level of the plate without spots (estimated locally using the blank regions to the left and right of each track).
19) ctivate smoothing by clicking the box 'Savitzky-Golay' and select a suitable filter width.
20) Back on the table, you see a column 'Offset' (if not, select 'Track Data' from the table header drop-down menu). Changing this value, you can shift each peak up or down until the track baseline is approximately zero. Clicking in the densitogram plot outside the peak shows a ruler with the height of each track at that position – providing a good estimate for the optimal offset value.
21) Though this has no impact on the actual calculations, you may want to enter the correct concentration unit in the text field, just above the track input table. This unit will later appear in exports and reports which you can generate about this Evaluation.

To see only one or selected tracks in the densitogram, expand the tracks' options in the table (if no track is expanded, the software will plot all tracks). Once you are satisfied with the densitograms of all peaks, you can continue with evaluating the peak measures and optimizing the regression settings.

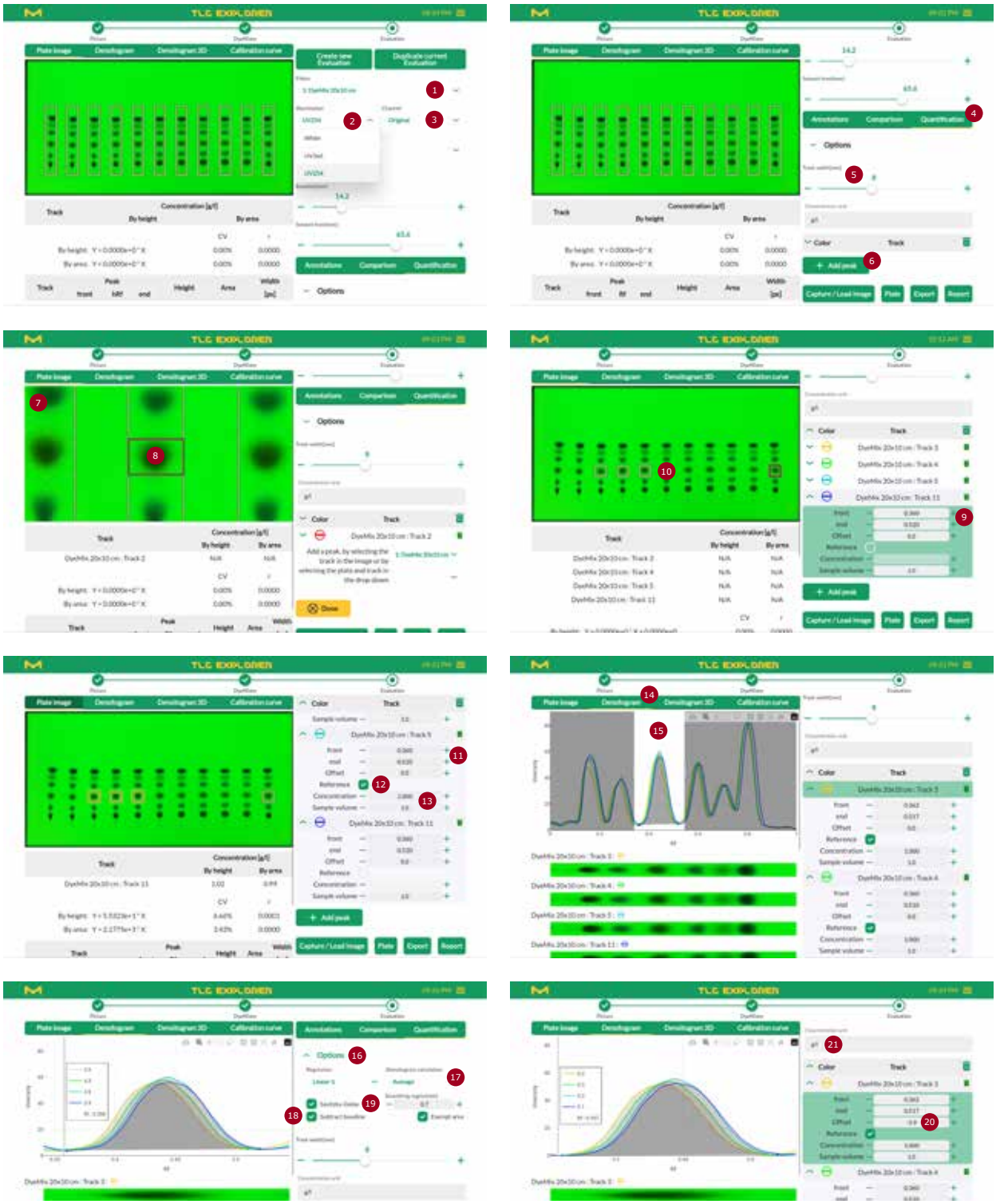


Figure 4.18: Prepare a quantitative analysis, step-by-step example

4.11.2 Reading Quantitative Measurements and Fine Tuning

Below the plate preview (or, depending on the selected tab, the densitogram) please find two tables summarizing the analysis results, which are updated automatically at every change made to the input values. Please note that these results are only relevant for correctly prepared densitograms (see previous section) with sufficient reference tracks for the selected regression method.

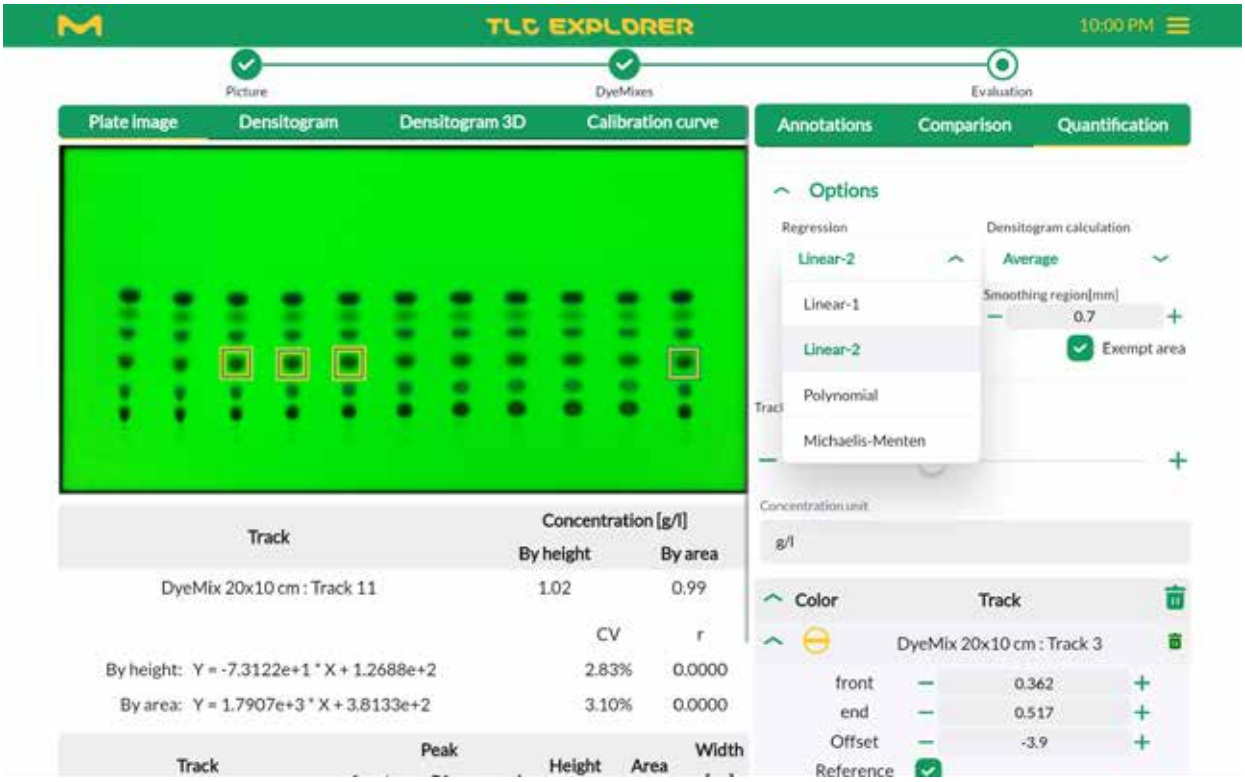


Figure 4.19: Choosing a regression method for quantitative analysis

The upper table lists the concentration for all non-reference tracks calculated by peaks' height and area. The exact regression formulas are given at the bottom of the table along with the regression coefficients 'r' and the standard deviation 'CV'. Choosing the tab 'Calibration Curve' above the preview image (or densitogram) shows you the corresponding plot and helps to evaluate the quality of the analysis. Depending on the number of reference tracks available, you may test different regression methods to see which one gives the most accurate results. The following alternative regression methods can be selected from the drop-down menu labeled 'Regression' in the 'Options' section under the 'Quantification' tab (where c stands for concentration, and x stands for either the peak area or height):

'Linear-1', requiring at least 1 reference track

$$c = ax$$

'Linear-2', requiring at least 2 reference tracks

$$c = ax + b$$

'Polynomial', requiring at least 3 reference tracks

$$c = ax^2 + bx + c$$

'Michaelis Menten', at least 3 reference tracks are recommended

$$c = \frac{ax}{(b+x)}$$

The lower table provides an overview of the peak details used for the calculations. Before using the quantitative results provided in the upper table, please check the lower table to see if the numbers there make sense.

In case you note unreasonable or unexpected values, you can always go back to the preparation steps described above and correct or fine-tune settings. With just a few clicks, you may even test if a different plate image ('Illumination'), or channel thereof, improves the quality of the analysis. Both result tables will update automatically to give you instant feedback on your changes.

4.12 Export Images and Evaluation Results

Prerequisites:

- You are on the 'Plate' or 'Evaluation' page
- Some exports are only generated if you entered data in the respective tables.

The TLC Explorer itself should not be the final destination for your plate documentation. In particular, it is not designed as a permanent storage for your results. For many use cases, you might want to only follow the workflow described above until it produces the result you need – be it a simple plate image, a table with densitogram data, or the detailed results of a quantitative analysis – to export it from the device and use it for your purposes.
If, for example, you simply want an image of your TLC plate under UV light, you only need to press the 'Download image' button on the 'Plate' page, which automatically opens after all images are captured. This button provides a shortcut to save the image you see in the preview area. To save another image, configure the preview with the 'Plate', 'Illumination' and 'Channel' drop-down menus, or click on the box 'Show Overview' for an image of the full Baseplate.

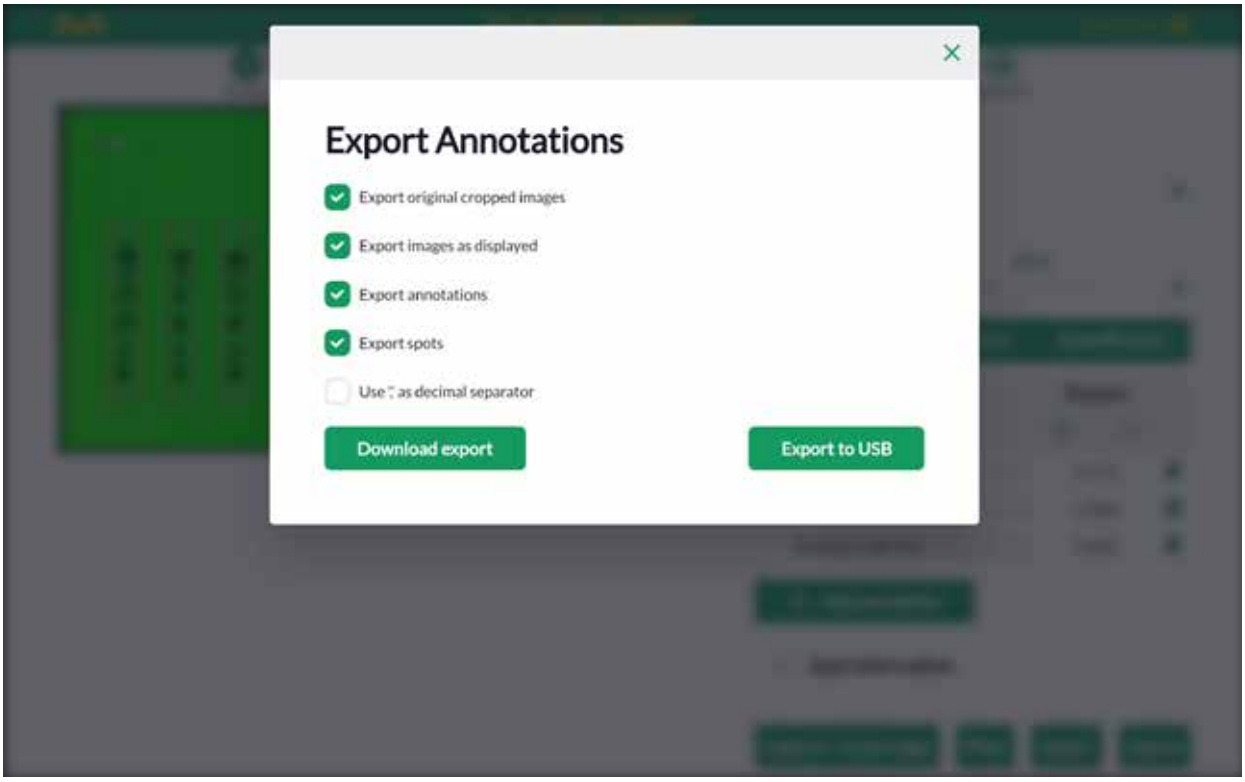


Figure 4.20: Evaluation export dialog for annotations.

Because tools on the 'Evaluation' page generate a variety of data – like densitograms, plots and tables – the 'Export' labeled button on the bottom of that page opens a dialog to let you select the specific data you wish to export (see figure 4.20). The dialog displayed also depends on the tab you have open:

4.12.1 'Export Original Cropped Images' (all tabs)

This export package includes the data generated on the 'Plate' page:

- all plate images, cropped and with the bottom edge aligned horizontally.
- a file for each plate named 'Plate_<plate name>.csv', which describes the plate with the meta-data added under the 'Info' section, and includes a table with details on all plate-related image files, e.g. the user capturing the image, the time and date, and the exposure time.
- the file 'Plate_<plate name>_Tracks.csv' containing the content of the tracks table of the 'Plate' page.

4.12.2 'Export Images as Displayed' (all tabs)

Choose this export package to get all plate images with the currently selected overlays (for details see section 4.8), i.e. as you see them in the preview area. The only exception: Annotation and spot indices will be replaced with their corresponding annotation text or spot name. To distinguish these images from the original plate images, they are marked with an '_overlay.jpg' suffix.

4.12.3 'Export Annotations' ('Annotations' only)

The upper table under the 'Annotation' tab (see section 4.9) is exported in files with a '_Annotations.csv' suffix for each plate. Beside the annotation text, the file includes the exact location in millimeters from the lower left plate corner as well as the image pixel coordinates. Please note that image pixels are typically indexed like matrices, i.e. the origin is the upper left corner and the y (or row) index increases in downward direction.

4.12.4 'Export Spots' ('Annotations' and 'Comparison')

Spots you named under the 'Comparison' tab in the lower table are exported in line with annotations, in files ending with '_Spots.csv'. Again, the exact location is given in both image pixel coordinates, and in millimeters, from the lower left plate corner. Additionally to the annotation table, spots include information about the track they belong to.

4.12.5 'Export Comparison' ('Comparison' and 'Quantification')

Each densitogram used for comparison, or as basis for quantitative analysis, can be exported as a separate CSV file. For traceability, it always includes a column with 'RAW_data' of each pixel, without smoothing or baseline subtraction, and a second column for the processed track.

To simplify plotting or processing of the exported data, the x-coordinate is given in this table at 3 different scales: pixel, hRF, and millimeters from the plate bottom.
Choosing this option also exports a file called 'Peaks from Comparison', which lists the automatically detected peaks of selected tracks.

4.12.6 'Export Quantification' ('Quantification' only)

Selecting this export package will include files with the quantification results as well as files with the underlying data and chosen settings for this calculation. To make the analysis reproducible, you should include the densitogram data and the used plate image in your export.

4.12.7 Download or Save Exported Files

The export dialog offers you two options to obtain the files. You may either download the selected files packed and compressed in a zip archive to the device you use to control the user interface, or save the same zip file on a USB memory stick attached to one of the ports on the device back (**B2** or **B3**).

4.13 Generate Reports on Evaluations

Prerequisites:

- You are on the 'Evaluation' page
- Reports are based on a specific Evaluation. Before pressing the 'Report' button, please check that the correct Evaluation is selected from the drop-down menu at the section top.

Clicking the 'Report' button at the bottom of the 'Evaluation' page makes the software compile an overview of your analysis. By default, it includes all the data you entered and all that was generated based on your input. You can reduce the content by un-checking the boxes to the right of the sections you would like to exclude.

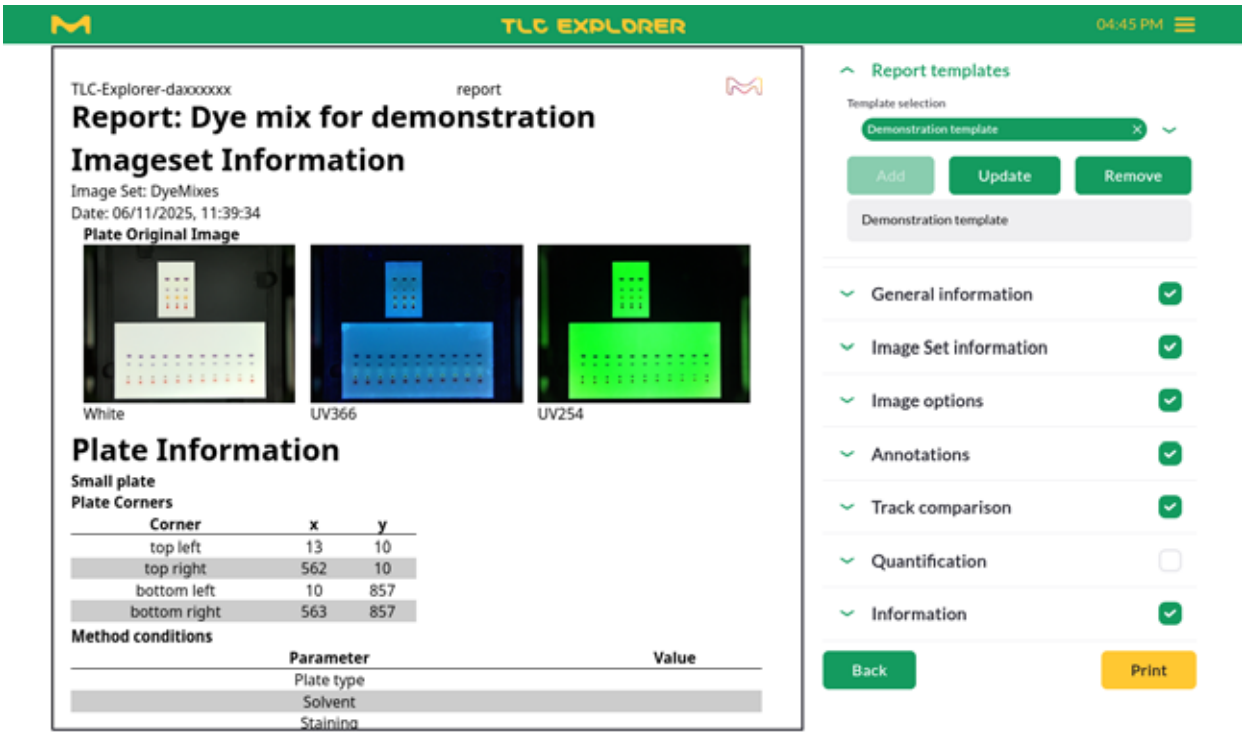


Figure 4.21: Creating and configuring reports on Evaluations

Expanding the different sections allows you to add additional information, e.g. a report title, or fine-tune the selection of content you would like to see included in your report. Some of the fields – e.g. the name of the image – are purely informative and cannot be changed in order to maintain the traceability of your analysis.
Each report also includes information identifying the device – like its serial number – and the software version. To verify later on that no image files or analysis data have been altered since the creation of the report, the report lists so-called hash-values of these files (generated using the MD5 message-digest algorithm). These are something like a fingerprint, and any changes to these files would result in different values.
To reduce entering repeatedly the same information, you can also save your report settings as a template by entering a template name at the gray field under the heading 'Report templates' and clicking 'Add'. Next time when generating a report, you can choose this template from the drop-down to have – as far as possible – the same configuration applied to your new report.
Reports can be exported as PDF files – just click on the 'Print' button – and then saved for later reference. Please note that images in the PDF are scaled and have a lower resolution than the original files. If you would like to use images in a higher resolution, they can be obtained from the 'File Manger' (see 4.14) or the Export feature (see section 4.12.1 and 4.12.2).

4.14 Manage Files and Image Sets

Prerequisites:

- You or another user have created at least one Image Set
- You opened the file manager by clicking on the main menu icon (three horizontal bars in the upper right corner), and then selecting 'File Manager'.

The file manager can be reached at any point in the workflow via the main menu in the upper right corner. If you would like to return to the page from where you opened the file manager, simply press the back-button at the end of the page.
All files, and thus also the file manager, are structured by Image Sets. Image Sets belong to a user and consist of the images captured together (under different illuminations), along with all plate images and data derived from those. An Image Set may include multiple Evaluations, each one with a separate copy of the plate images and track data, on which the Evaluation (e.g. track comparisons or quantitative analysis) is based (for details please see section 4.8).
When opening the file manager, the table lists Image Sets that belong to the currently logged-in user. To also see Image Sets from other users, un-check the box in front of 'Only my files' in the upper right corner. Left of that checkbox is a text input field marked 'Search', which allows you to filter the list for Image Set names that include the text you entered.

At the bottom right corner of the file manager, you can see the 'Remaining free space'. Please have at least 250 MB free to ensure the system runs smoothly.

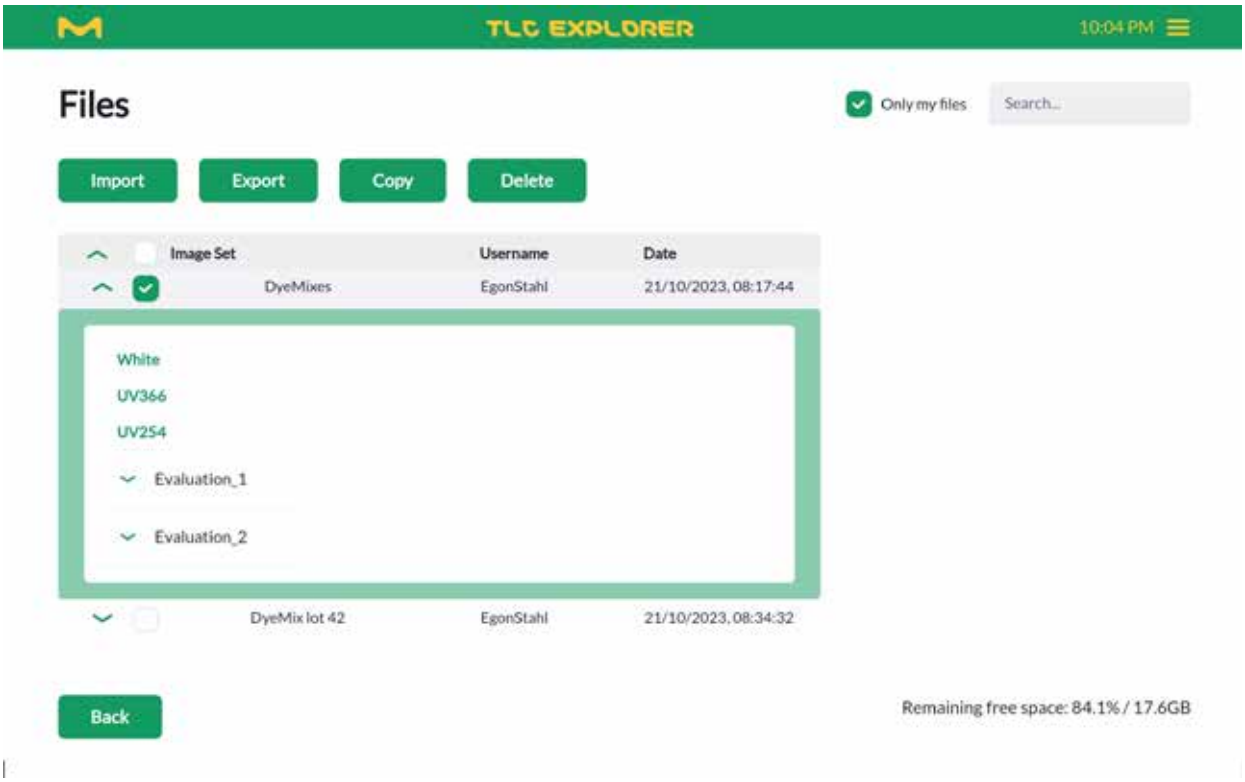


Figure 4.22: File manager

4.14.1 Exporting Image Sets and Downloading Images

A common task is to download a specific plate image. This can be easily done by expanding the corresponding Image Set in the table (click on the arrow at the beginning of the row). To obtain the raw images, as taken by the camera, click on the desired illumination type listed in green – a preview will appear and allow you to download the image. Cropped and aligned plate images can be found by expanding an Evaluation and selecting the illumination there. If multiple plates were found in your raw images, plate images are listed below the respective plate name.
Exporting one or multiple selected Image Sets usually has a different purpose, because the resulting zip file includes all related files as they are stored on the TLC Explorer. For structured data, e.g. formatted as tables in CSV files, please use the export option on the 'Evaluation' page (see section 4.12) or generate a report (see section 4.13). Exported Image Sets serve mainly to permanently store the data at a suitable external location, so that they can be (re-)imported on the same or transferred to another TLC Explorer device in the future.
To export Image Sets, check the boxes to the left of the desired Image Sets and then click 'Export'. The dialog that opens provides the option to delete the data on the TLC Explorer after you have successfully exported the data. You can also decide to save the data on a USB memory stick (attached to **B2** or **B3**), instead of the default of downloading the zip-file. It is recommended to check the exported data, verifying that the correct Image Set was selected. To detect possibly corrupted exports, just start an import process (see below) with the exported file (no need to actually import it): the import function will automatically check if the set is complete and valid.

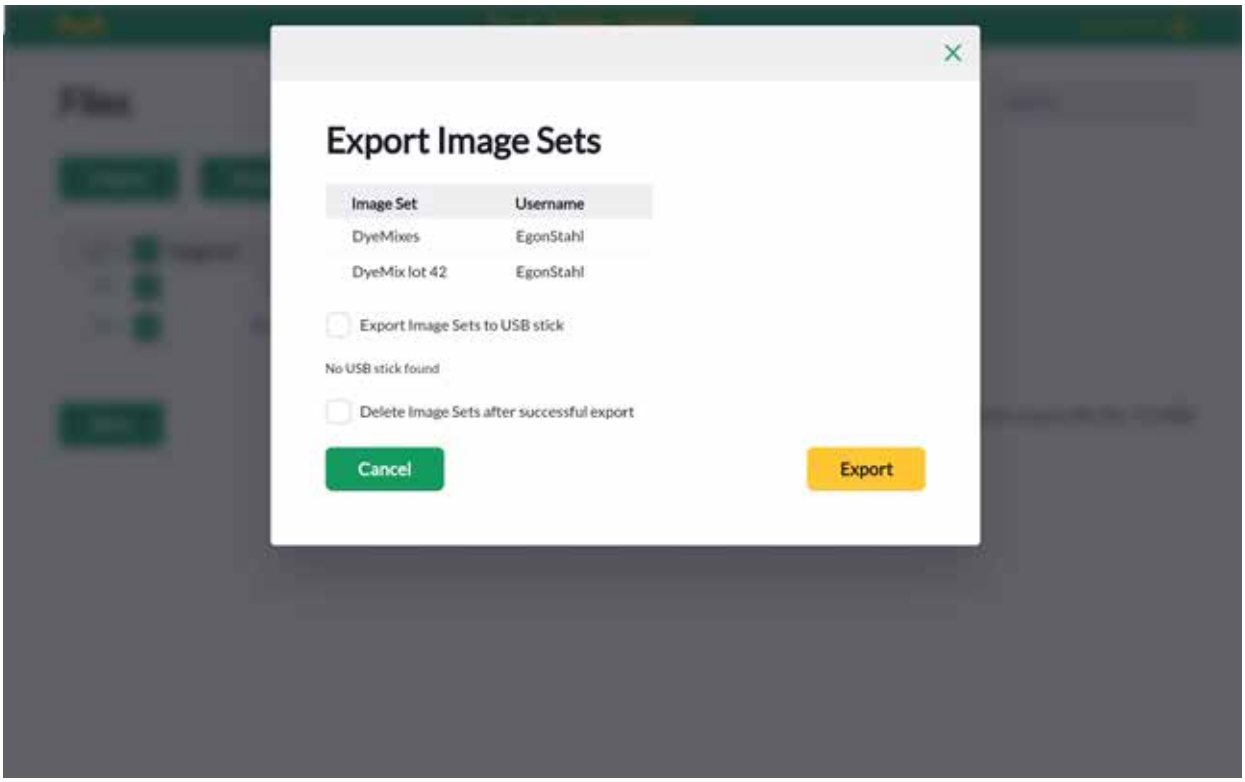


Figure 4.23: Export Image Sets dialog in file manager

4.14.2 Copy or Import Image Sets

Users can only load and process their own Image Sets. To work with the Image Set from another user, un-check the option 'Only my files' in the upper right corner, find and select the desired Image Set, and then click on 'Copy' to create a copy that then belongs to the logged-in user. You can, of course, also copy your own Image Sets.
Exported Image Sets can be imported on the same or other devices, allowing not only to restore the data, but also to share it with other laboratories that work with TLC Explorers. The data needs to be in the original zip format, complete and uncorrupted, or the import function will reject it.

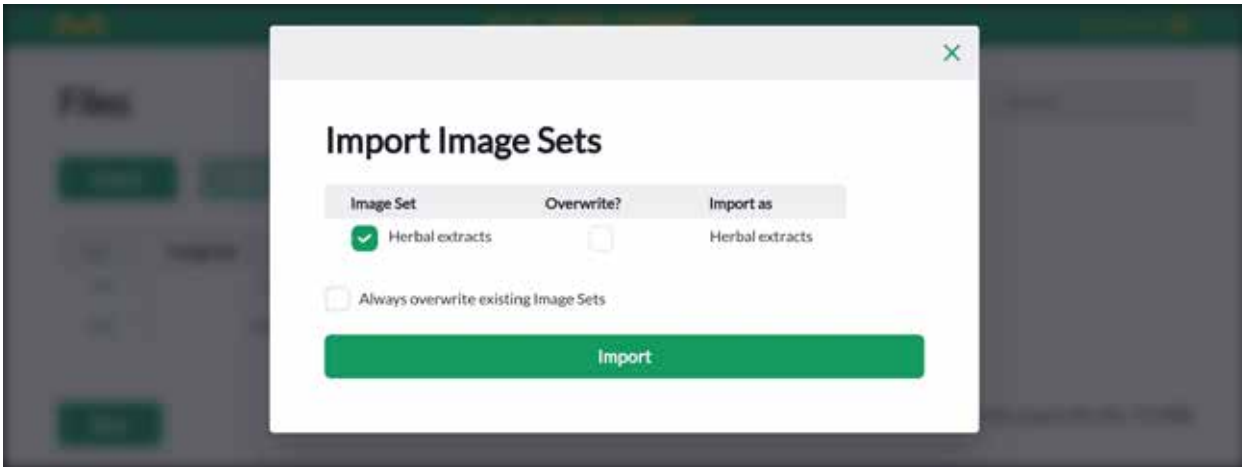


Figure 4.24: Import Image Set dialog in file manager

4.14.3 Deleting Image Sets

It is recommended to regularly check the remaining storage capacity, shown in the bottom right corner of the file manager, and delete obsolete Image Sets.
Before deleting data, you can either backup the full device (see section 6.1), or export selected Image Sets to a suitable permanent storage location (see section 4.14.1 above).
When you are sure that Image Sets stored on the TLC Explorer are no longer needed (e.g. because a copy is stored elsewhere), check the box to the left and click on 'Delete'. You will be asked to confirm the deletion for the listed Image Sets before the data is permanently deleted. This cannot be undone.

4.15 Reset or Shut Down Device

Like any desktop computer, the TLC Explorer needs to be properly shut down before unplugging the power supply. Failing to do so may damage the device.

You can find details on the different ways and options to restart or shut down your device in section 3.6 'Powering Down'.

5 User Management, Device Settings and Qualification

Prerequisites:

- You are on the 'Settings' page, which can be reached via the 'Settings' option in the main menu (see figure 4.3)

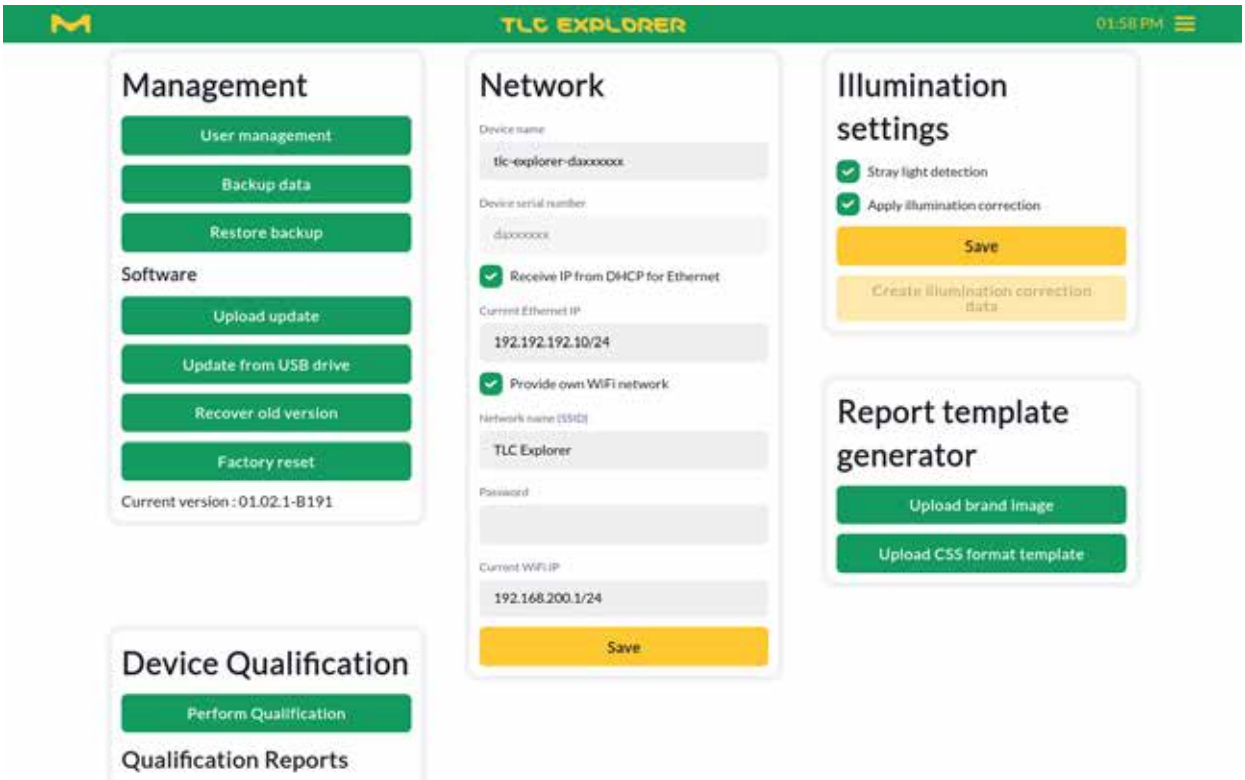


Figure 5.1: Settings page

Multiple users can work simultaneously on the TLC Explorer. This allows different users to access and process previously recorded plate images, while e.g. another user is capturing new plate images. However, as it is physically only possible to take images of one Image Set at a time, the system coordinates parallel activities, or so-called 'sessions', to ensure the following two conditions are met:

- Only one user can capture images.
- A user can only be logged-in at one browser (e.g. on the tablet or laptop).

In case a second user tries to capture images while another user is already doing so, the system will issue a warning and lock the feature until the first user has completed the image capture process.
Logging-in as user at the welcome screen (see figure 3.5) will automatically end all other sessions of that user on other devices.

5.1 Changing Active User

You can easily change the active user by opening the main menu – as shown in figure 4.3 – and select there the option 'Change User'. This will logout your current user and redirect you to the login screen (figure 3.5), where you can select the new user and then press 'Login'.

5.2 Adding and Deleting Users

To add or delete users, choose 'Settings' from the main menu, and then click the button labeled 'User Management'.
New users can be added by clicking on 'Add a new user', and then entering the username and optionally the full name (as used e.g. in reports) along with the user's language preference in the dialog that appears.
Users can be deleted by clicking the trash icon in the table listing all users. A dialog opens, asking you to confirm the deletion. Moreover, a checkbox lets you choose if the data associated with the username should be deleted together with the user. If this box is not checked before clicking 'Delete', the user's Image Sets will remain on the device and can be found in the file manager (see section 4.14) listed under the username 'DELETED_USERS'.

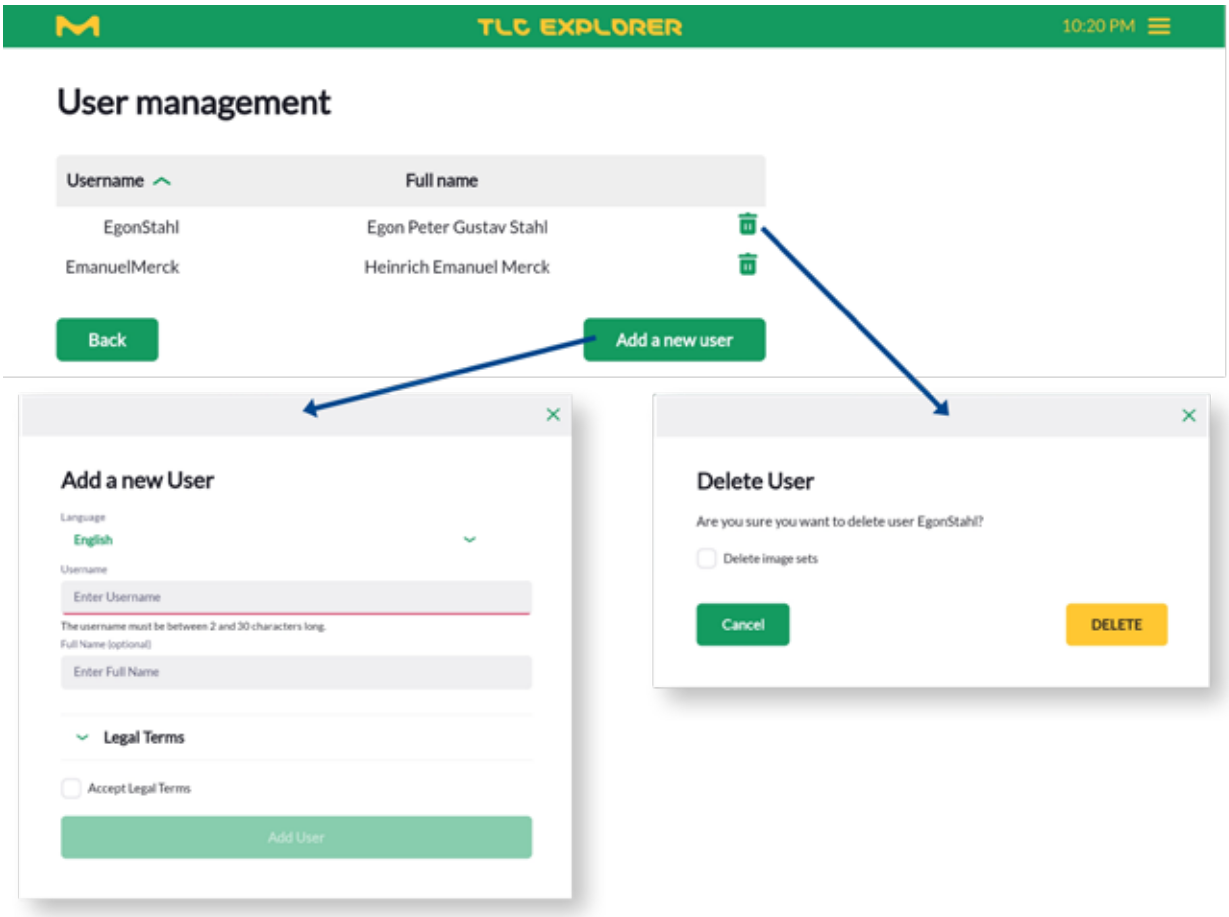


Figure 5.2: Adding and deleting users

5.3 Device Name and Serial Number

Under the heading 'Network', you can find the 'Device name' and 'Serial number'. The latter cannot be changed and should be identical with the number you find on the device housing (see **B6**).
The 'device name', however, can be set by users and will be used to identify the device in reports, exported data and networks (see section 8.2). Especially if you employ multiple TLC Explorer in your laboratories, a unique name will help to trace back results (e.g. exported plate images) to the correct device. Please remember to press the 'Save' button to apply your changes.

5.4 Time and Date

The TLC Explorer has no internal clock running while the device is off. Therefore, the software tries to obtain the current time and date from the user's device (e.g. laptop or tablet). Alternatively, you can set the date and time manually on the 'Setting' page. Please remember to press the 'Save' button to apply your changes.

5.5 Digital Illumination Correction

To improve the illumination homogeneity, images can be corrected digitally based on a series of images from a reference plate.
To calibrate the system, place a white, flat 20.5 cm by 20.5 cm copier/printer paper on the Baseplate and close the drawer. Then press the button 'Create illumination correction data' under the heading 'Illumination Settings' and follow the instructions on the screen. Do not open the drawer or inspection window before the process has been completed. The system takes multiple images under all available light sources and then calculates correction matrices for each illumination type.
Please note that an incorrectly calibrated illumination correction may cause artifacts in your images and diminish the quality of your results. To check that the calibration brings the desired improvement, manually rotate the reference plate on the Baseplate by 90 degrees and capture a test Image Set. Ignoring a margin of about 1 cm on each edge, the plate should look equally bright allover.
You can activate or deactivate the digital illumination correction with the checkbox labeled 'Apply illumination correction'.

5.6 Stray-light Detection

When 'Stray-light detection' is activated, the system checks before capturing images, whether the inspection window is correctly shut. In case the Baseplate is not completely dark with no light source on, the software issues an error message and stops the capture process.
It is recommended to enable this feature, as it helps to prevent capturing images with artifacts or reduced contrast and thus increases the data quality for all following processing steps.

5.7 Device Qualification

To verify that a specific TLC Explorer functions correctly and reliably, a device qualification is recommended – if not even mandatory, according to the applicable regulatory environment – after installation, software or hardware changes. Such changes, for instance, could be a software update (see section 7) or an exchange of the illumination unit (see section 10.4).

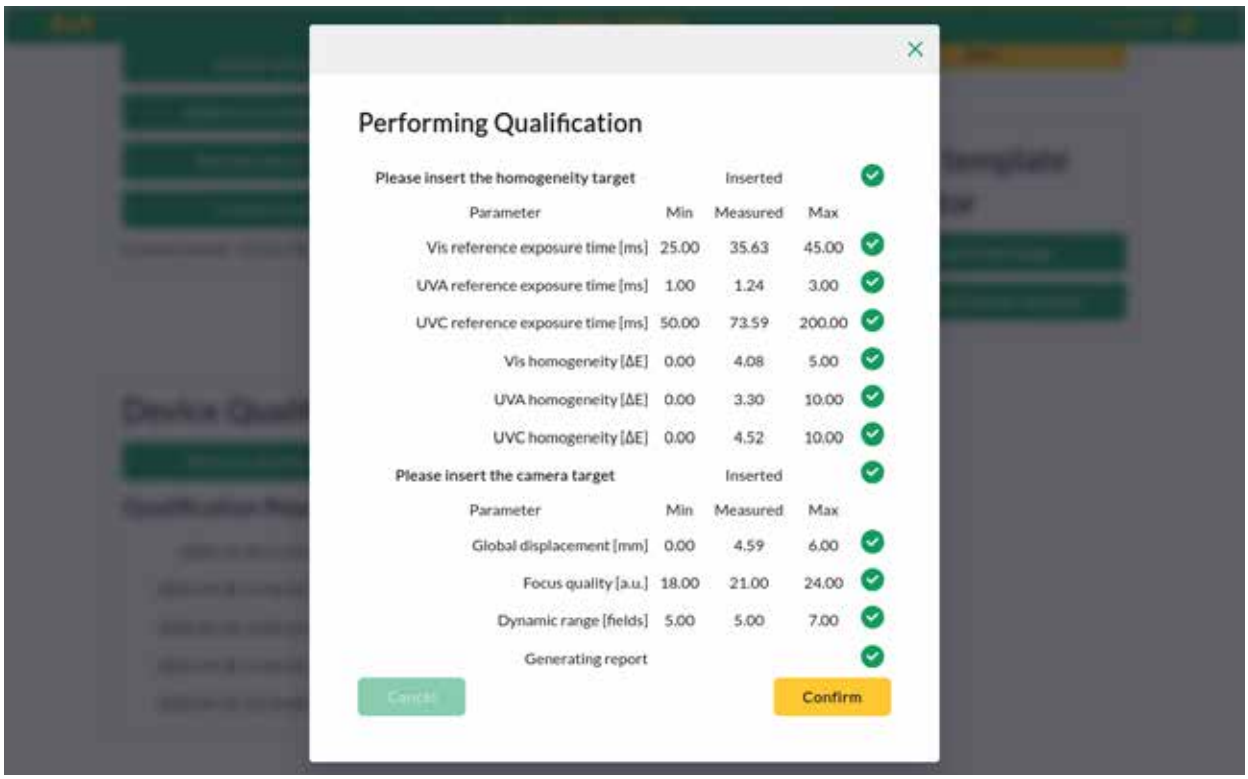


Figure 5.3: Performing a device qualification

Under the heading 'Device Qualification', the Settings page features a semi-automatic tool to support you in your device qualification processes. It requires a valid reference target (see section 10.3 how to obtain suitable targets), which on one side is blank (white), and on the other side features specific fiducials (reference marks and measurement patterns) to validate various aspects of illumination and camera operations.

After opening the tool with a click on 'Perform Qualification', the system asks for information about the reference target, which are needed for the report generation later on. As seen in Figure 5.3, the operator should then insert the homogeneity target, which is the blank white side up, onto the Baseplate and click on 'Start measurement'. In case 'Vis homogeneity' fails with a value around 70, it is likely that the wrong target side is upside – please verify that the blank side is seen by the camera for this step.

After completing the illumination validation, turn the target with the fiducials towards the camera and click on the seconds 'Start measurement' button. Once all measurements are completed, the system generates a report, and, upon clicking 'Confirm' lists the resulting report under 'Qualification Reports', where it can be opened by clicking on the cloud symbol.

6 Backup and Data Migration

There are multiple options to export data generated on the TLC Explorer. If you wish to save a selection of Image Sets, it may be faster and more flexible to use the file manager (see section 4.14). The Backup functionality takes all user data on the device – not only from the user currently logged-in – and compresses it as a single file that can be used to restore user settings on the same device or clone them at another TLC Explorer.

6.1 Generating a Backup

From the main menu, select 'Settings', and then click on 'Backup data' under the 'Management' heading. In the dialog that appears (see figure 6.1), you can choose whether you would like to download the backup file through the web browser or store it on an attached USB stick.
By default, the backup includes all Image Sets, but no user settings. To include these in the backup, check the respective checkbox before choosing the storage option.
Depending on the amount of Image Sets and Evaluations you have stored on your device, backups might take several minutes to complete.

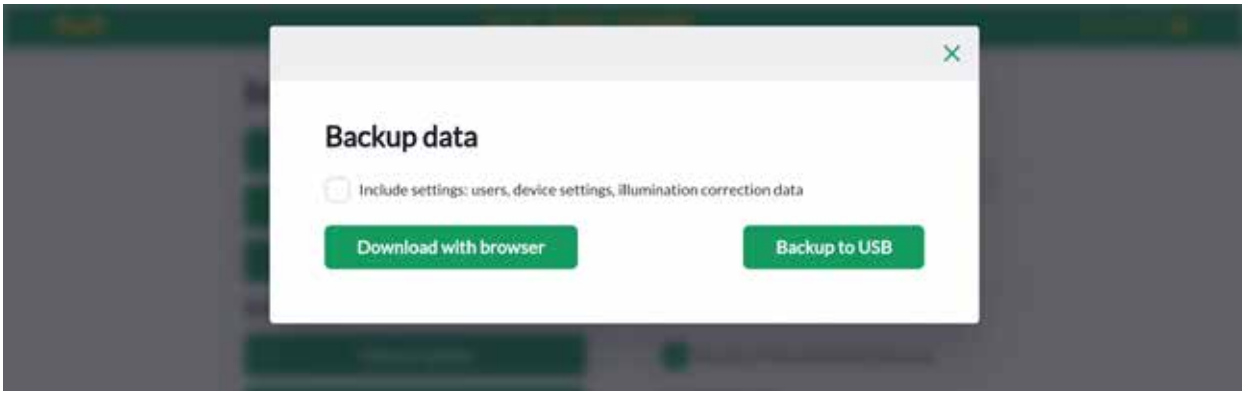


Figure 6.1: Dialog to backup all user data and settings on device

6.2 Recovering Backup

The same dialog (that opens after clicking on 'Backup data' under the 'Management' heading) offers to restore a backup from either a USB drive or after uploading a backup file. Once the user has confirmed, that all user data and settings should be overwritten with the backup data, the system may take several minutes to complete the process. The system then automatically restarts, and the browser should navigate to the login page as soon as the device is ready for operation again.

6.3 Migrating User Data to a different TLC Explorer

Cloning the user data and settings on a different device is done the same way as a recovery on the same device. However, due to the different hardware and potentially different software version on the target device the following two precautions are recommended:

- To ensure compatibility of the Image Set data, ensure the target device runs the same or a newer software version than the backup's origin. Ideally update to the most recent software version before starting the restoration process.
- A backup might include illumination correction data. While probably similar, the correction matrix should be recalculated for the new device according to the steps described in section 5.5.

7 Software Updates

Prerequisites:

- You are on the 'Settings' page, which can be reached via the 'Settings' option in the main menu (see figure 4.3).

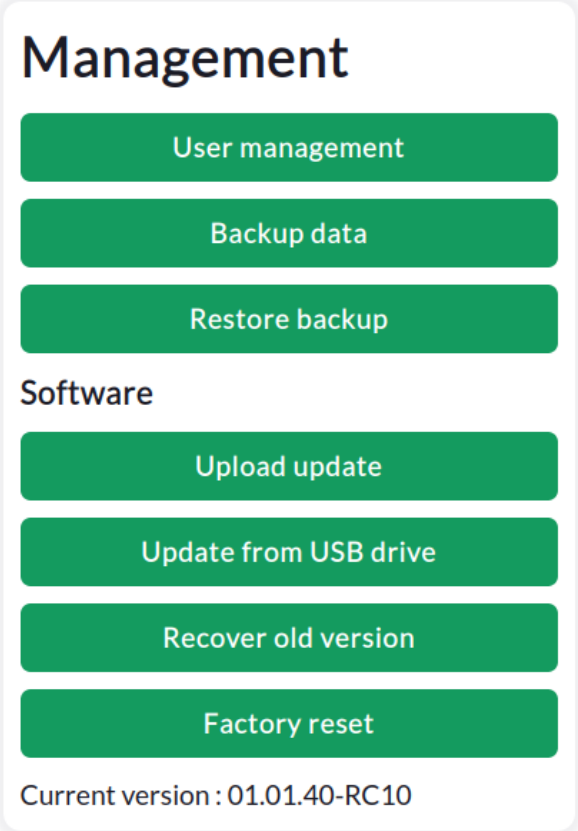


Figure 7.1: Software version related operations are started from the 'Management' box on the settings page.

7.1 Current Software Version

The current software version of a device can be seen on the 'Settings' page under the heading 'Management', where on the last row the exact version number is shown (see figure 7.1).

7.2 Obtaining Software Update

To keep your TLC Explorer up-to-date with new features and security improvements, please check regularly for newer software versions on the TLC service website. By scanning the QR code shown in figure 7.2, or manually entering the link https://sigmaaldrich.com/TLCservice at your web browser, you will be directed to a website with the latest information about TLC Explorer products and available software updates.
Simply download there the latest software update file to your computer or mobile device. Compatible software will be clearly marked with the product ID 1.52610.0001.
Please note that updates need to be initiated by the user – the TLC Explorer does not automatically search for updates, even if connected to the Internet.

Figure 7.2: Software updates are available at:
https://sigmaaldrich.com/TLCservice

7.3 Installing Update

There are two options to transfer a software update to your TLC Explorer: You can either upload the file directly in the web browser, or copy the update file on a USB memory stick and then connect that stick to the device.
Uploading updates through the web browser is the easier and thus recommended way: On the settings page under the heading 'Management' click on 'Upload update', select the file from your computer or mobile device and click on the button 'Upload update'.
The update process can take several minutes and includes a reboot of the TLC Explorer. Please do not unplug the device while updating, and wait for the process to be completed. Usually, the browser will automatically recognize when the TLC explorer is operational again, and then redirect you to the Login page. In case the browser does not support this mechanism, simply open the TLC Explorer website about a minute after the power icon **F1** has stopped flashing and is shining brightly.
To update the TLC Explorer from a USB memory stick, copy the update file on the stick's root directory, i.e. not in a folder. After connecting the stick to either of the USB-A ports **B2** or **B3**, click on "Update from USB drive" (see figure 7.1). A dialog will open and lets you choose the software version you would like to install (in case there is more than one update file on the memory stick). Please allow the system a few minutes to complete the update process.
In case an error occurs during the update process, the system will automatically roll back to the software version installed when starting the update.

7.4 Recovering Previous Software Version

If needed, the user can also manually go back to the previously installed software version. Clicking on the button 'Recover old version', the software downgrade menu opens and lists available older software versions. The system only stores one previous version and the software version installed when the device was delivered. Simply select the desired version and click on the button to install it. Just like the update process, the downgrade process can take several minutes and includes a reboot of the TLC Explorer.
If you wish to install a different older version than those listed in the software downgrade menu, you can use the installation process described above in section 7.3.

7.5 Factory Reset

Initiating a factory reset should be done with care, as **it erases all users with their data as well as all settings, including network settings**. If you only need to reset network settings, please refer to section 8.4.
A factory reset also re-installs the software version with which the device was delivered, and erases all other software versions from the device.

There are two options to start a factory reset:

1. Click on 'Factory reset' under 'Management' on the settings page, and confirm your intent in the dialog that opens.
2. Touch and hold all three illumination buttons (**F2**, **F3**, **F4**) while the TLC Explorer is starting, i.e. as long as the power icon F1 is flashing.

8 Connecting the TLC Explorer

The TLC Explorer features multiple connecting options to easily integrate into existing laboratory networks and to provide its own networking infrastructure. Most set up options are straightforward. However, integrating the device into your laboratory's network may have unintended consequences. Depending on the network configuration, everyone with access to the network also has access to the TLC Explorer device. Neither user data nor device settings are protected by passwords, as it is assumed that physical and digital access is controlled by the laboratory manager.
Please note: Connecting the device to an existing network should only be done after consulting your network administrator.
To connect to your TLC Explorer for the first time, please refer to section 3.4, where the process of linking your laptop or tablet to the TLC Explorer and opening the user interface is described in more detail.

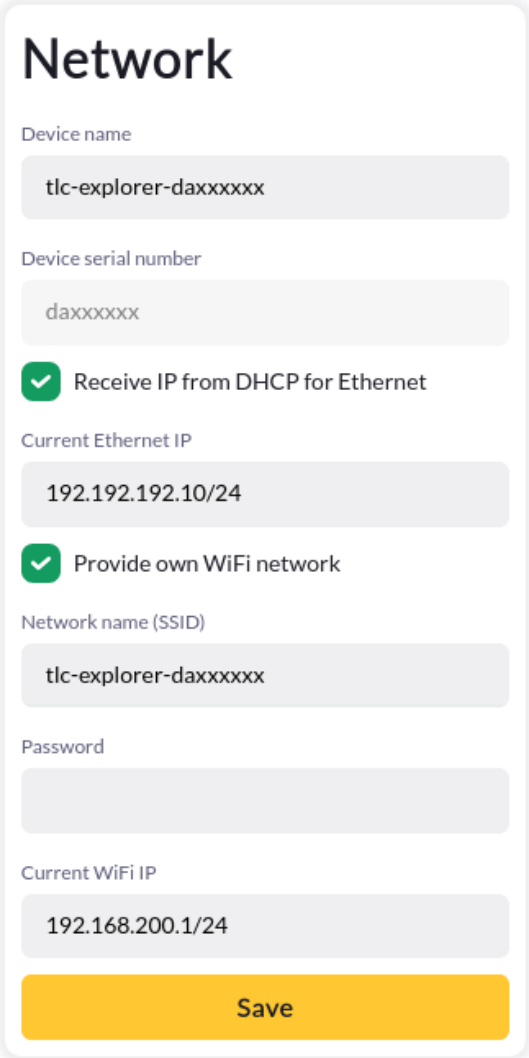


Figure 8.1: Connection settings can be configured under 'Network' on the settings page.

8.1 TLC Explorer's own WiFi

As long as the factory settings have not been changed, or after they have been reset (see sections 8.4 and 7.5), the device broadcasts its own WiFi signal. You can easily connect to this network by scanning the QR codes on the sticker provided in the package. The QR code 1 contains all the information your tablet or smart phone needs to connect to the WiFi broadcasted by the TLC Explorer. Just scan and follow the instructions given on the screen.
Alternatively, you can also open the network settings of your tablet or desktop PC (if the latter has a WLAN adapter), and search for a network name (SSID) starting with "tlc-explorer" (followed by the serial number **B6**). Choose 'WPA/WPA2' as the security setting and enter the default password written on the QR sticker (the password can be found after the device name in "Step 1") to establish the connection.
Your mobile device may warn you that the chosen WiFi has no internet connection – this is correct and by design. However, some mobile devices will give preference to network connections that have internet access. It might, therefore, be necessary to open your mobile device's WiFi settings and disable the 'Auto-connect' for saved networks that have internet access – those which are also available apart from the TLC Explorer.
In case the tablet, laptop or phone is primarily intended to control the TLC Explorer, we recommend activating 'Auto-connect' for the TLC Explorer's WiFi entry and deactivating it for all other networks. Otherwise, you will need to manually reselect the TLC Explorer network after every time the connection was interrupted (e.g. because the tablet or TLC Explorer were restarted).
The name (SSID) of the WiFi that the TLC Explorer broadcasts can be changed under 'Network' on the settings page. There you can also set another WiFi password to protect access to the network and thus the device. Before pressing 'Save' to confirm the changes, please verify that the box before 'Provide own WiFi network' is checked.

8.2 Integrating in LAN via Ethernet Cable

Before plugging an Ethernet cable into the RJ45 port **B4**, please contact the network administrator. By default, the TLC Explorer will expect to be assigned to an IP from a DHCP server on that network. In case a static IP is necessary, the checkbox in front of 'Receive IP from DHCP for Ethernet' can be unchecked and the static IP address entered in the field 'Current Ethernet IP'. To receive the IP from a DHCP server again, you will need to check the box, click on 'Save' and then reboot the device.
In case the connected LAN features a local DNS server, you can reach the TLC Explorer from any other device on that network by entering http:// followed by the device name as shown under the 'Network' heading on the settings page. Especially if your laboratory uses multiple TLC Explorers, it may be useful to assign them distinct device names, to then bookmark the respective name based addresses in your web browser (e.g. http://tlc-explorer-quality-lab, or http://tlc-room214). If no local DNS is available, you can also reach each TLC Explorer by the IP shown under the label 'Current Ethernet IP', e.g. by entering http://192.192.192.10 (without the '/24') in the browser bar.

8.3 Integrating into an existing WiFi Network

Instead of providing its own WiFi network, the TLC Explorer can also connect to an existing WiFi network. However, if it is possible to connect the device with an Ethernet cable, that option would usually be preferable.
To set up the connection to an existing WiFi network, you need the exact name (SSID) and password of that network. Un-check the box in front of 'Provide own WiFi network' and enter the network name and password in the fields below. Carefully check that both name and password are entered correctly, as a false entry can cause the TLC Explorer to be unreachable and require a network connection reset, as described in section 8.4. Only when sure, click on 'Save'.
Similarly to the connection with an Ethernet cable (see section 8.2), you can either reach the TLC explorer from any device within the WiFi network by entering http:// followed by the device name (if DNS is available) or the device IP in the web browser bar.

8.4 Resetting Network connection

In case some changes to network settings, or a forgotten WiFi password, hinder you from connecting to the TLC Explorer, the network settings can always be reset to the factory default.
To reset the network connection you need to power down the device by pressing the power icon **F1** until the light below is only dimly shining. Then touch and hold any two illumination buttons (**F3**, **F4**) while the TLC Explorer is re-starting (i.e. as long as the power icon **F1** is flashing). **Do not** press all three illumination buttons, as this will initiate a complete factory reset where all user data and settings are deleted (see section 7.5).

8.5 Mounting TLC Explorer as Network Location (SMB)

Besides exporting images and Image Sets with the file manager (see section 4.14.1), it is also possible to access all user data using the samba server running on the TLC Explorer. Windows users in the same network as the TLC explorer should find the device name listed under 'Networks' in the Windows Explorer, while Mac users should see it under 'Shared' in a Finder window. Ubuntu users need to press Ctrl + 'l' in a Nautilus window and enter smb:// followed by the device name (if DNS is available) or the device IP. Independent of the operating system, the access does not require any username or password (anonymous), and should show a folder named 'data', which then contains a sub-folder for each user and their Image Sets.
To protect the data integrity, it is possible to read and copy Image Sets on your local desktop or laptop, but it is not possible to write on that directory.

9 Troubleshooting

9.1 Identifying Errors

An unexpected behavior or error message is sometimes the consequence of a previous unnoticed error. To speed up the search to find an error's origin and potential solutions, the chart in figure 9.1 lists a sequence of checks. Once the issue has been identified, please follow the possible remedies referenced by number to the right of the issue.

Please **do not** unplug the system from the power supply without properly shutting it down (see section 3.6). Doing so may seriously harm the computer system inside the TLC Explorer and cause additional problems. A safe alternative to shut down and reboot the device is to press and hold the power icon **F1**.

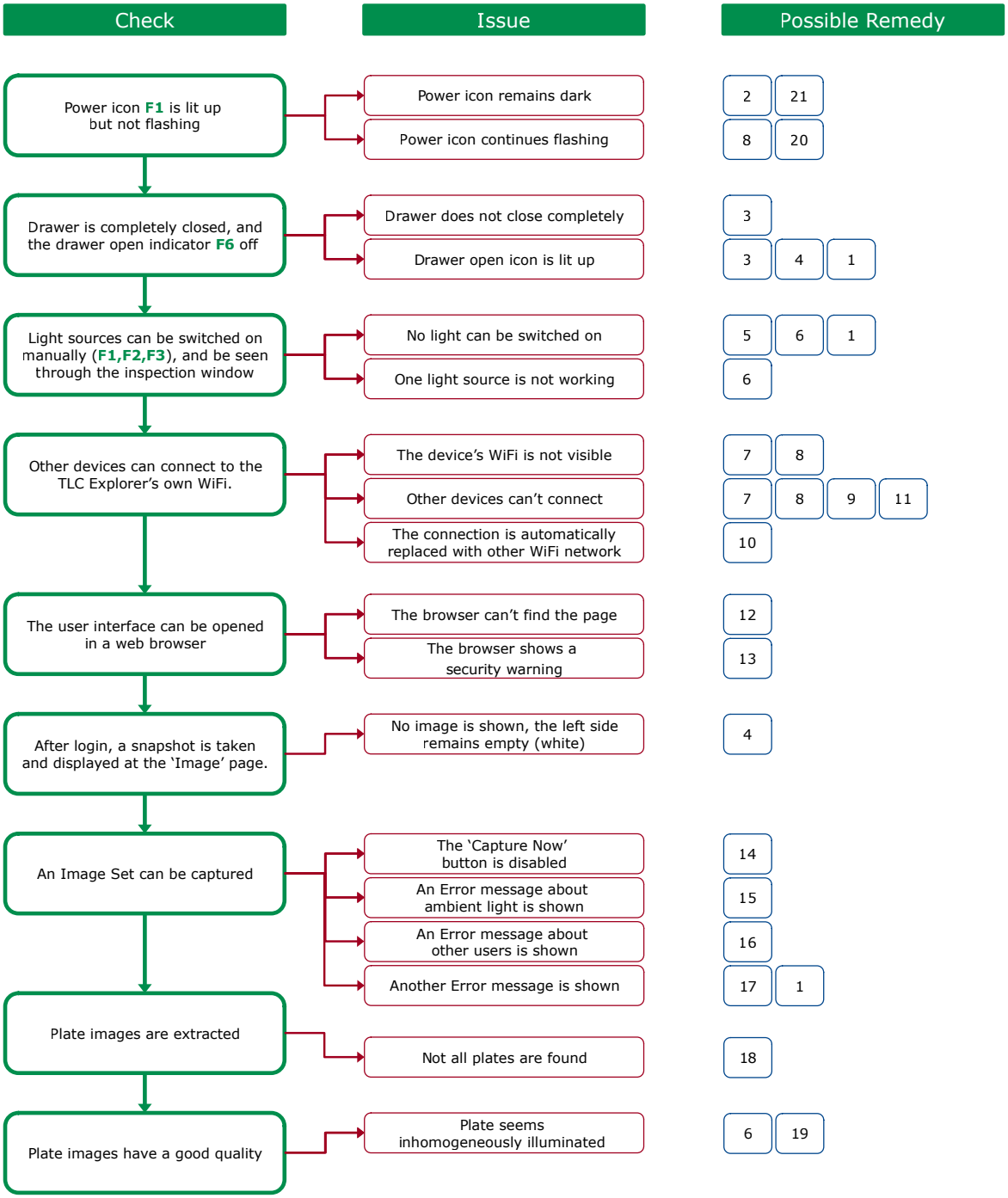


Figure 9.1: Identifying issues and how to address them

9.2 Possible Remedies and Solutions

1) To reboot the device, hold a finger on the power icon **F1**, until the icon starts flashing (indicating the device is shutting down). After the icon has stopped flashing and remains in a dimmed state, wait a few seconds and press the icon again to restart the device.
2) If the power icon does not light up, the device may not be connected to a working power supply. A simple way to check the power source is to connect a tablet or mobile phone to the USB-C connector that is plugged in the USB-C port at the device back. However, this test only applies to the USB-C power adapters recommended for the TLC Explorer (see section 2.4) – third party power adapter and cables may charge a phone but have specifications that are incompatible with the TLC Explorer. In case the power adapter and cable work as desired with other devices, but not the TLC Explorer, you may need to contact the reseller of your device for technical support (see section 10.2).
3) In case the drawer does not close completely, verify that the alignment pin **P3** underneath the Baseplate has entered the socket **P4** on the drawer, so that the Baseplate lies flat on the drawer (see section 2.3.3). There should be no objects higher than 8 mm on the Baseplate (see section 2.3.1). If the drawer seems blocked by an object inside the device, you can open the back cover **B7** and remove the obstacle.
4) The red drawer open light **F6** is on whenever sensors indicate that the drawer is not closed correctly. While the drawer is open, light sources cannot be switched on and no images can be taken. Check if the drawer really is correctly closed. In rare cases, a software or sensor issue might cause the systems to incorrectly detect the drawer as open. If you suspect this to be the case, reboot the device.
5) For safety reasons, the TLC explore only allows the switching on of light sources if the drawer is correctly closed and the back cover **B7** correctly installed. Also, while another user is capturing images, manual light switches **F2**, **F3**, **F4** are deactivated.
6) If one or all light sources are not working, or the illumination appears to be dark on one side, the illumination unit might need to be replaced (see section 10.4). In case a replaced illumination unit remains dark after the replacement procedure, verify that the unit's power connector is plugged in (see figure 10.3), and the back cover **B7** has been correctly closed.
7) Issues with the WiFi configuration may also be resolved by connecting to the device using an Ethernet connection (see section 8.2). You can then access the settings page and correct the configuration via the Ethernet connection (see section 8).
8) To reset all network settings to their default values, please follow the instructions given in section 8.4. You should then be able to connect to the TLC Explorer's own WiFi network by following the steps described in section 3.4.
9) The network administrator may have installed security measures on the network configuration, or your device settings, preventing your device(s) from connecting to the TLC Explorer. If in doubt, please ask your network administrator.
10) As described in section 8.1, some mobile devices will give preference to network connections that have internet access, which the TLC Explorers own WiFi network does not have. It might, therefore, be necessary to open your mobile device's WiFi settings and disable the 'Auto-connect' for saved networks that have internet access – those which are also available apart from the TLC Explorer.
11) Please note that each TLC Explorer broadcasts a WiFi signal with a different name (usually including its serial number) which is possibly protected by a different password. In case your laboratory works with multiple TLC Explorer devices, use the QR code on the sticker for the specific device to connect (as long as the default network settings have not changed).

12) The TLC Explorer tries to inform all devices in the same network that it can be reached with the URL "http://" followed by the device name (see section 5.3). However, some networks may not support this feature and require users to address the device by its IP address, e.g. "http://192.168.200.1". This may also be necessary, if mobile devices in parallel feature an internet connection via mobile data and try to find the URL "http://" followed by the device name in the world wide web.
13) Some browsers enforce encrypted connections and may automatically change the entered address to begin with "https://", to then produce a warning that the site may not be secure. The browser cannot know that you are accessing the TLC Explorer in a protected local network, posing far less risk than opening a site from the internet. Alternatively, you may disable "https-only" in the browser settings (see also section 3.4).
14) The 'Capture Now' button is only enabled if a unique and valid Image Set name has been entered and the system is not busy with image capture. An extended delay may occur if a user has pressed an 'Auto' button multiple times in the 'Use manual Exposure' section to find the optimal exposure time. This process may take a while, especially for UV-light sources, because a series of images has to be captured and processed.
15) To ensure no stray light is impacting the image quality – e.g. due to an open inspection window **F7** –, the camera checks if the Baseplate is completely dark with no light source on before starting the image capture process. This check can be disabled on the 'Settings' page, though it is recommended to enable it (see section 5.6)
16) Only one user at a time can capture images. While other users may load and process Image Sets in parallel, competing attempts to capture images will cause error messages.
17) If the available storage space is insufficient to save captured images, an error message will appear. Please transfer all data not currently needed for processing to other devices and delete their copy on the TLC Explorer. At the bottom right corner of the file manager (see section 4.14), you can see the 'Remaining free space'. Please have at least 250 MB free to ensure the system runs smoothly.
18) The software searches for TLC plates as bright rectangular shapes with a minimum size. To get multiple plates detected automatically, place them a few millimeters apart, so that the device detects at least 2 mm of the black coating around each plate.
19) If the plate appears correctly illuminated through the inspection window **F7**, but inhomogeneously illuminated in the plate image, an incorrect illumination correction might have been applied. It is possible to deactivate the correction step, or to recalibrate the calculation. For details, please refer to section 5.5.
20) As an ultima ratio, all user data, settings and software updates can be deleted by performing a factory reset, as described in section 7.5.
21) Contact the reseller of your TLC Explorer for technical support.

10 Cleaning, Maintenance, and Decommissioning

10.1 Cleaning

It is recommended to clean the TLC Explorer – and especially the Baseplate – with a damp lint-free tissue on a regular basis. To remove more resilient dirt, the cleaning tissue may also be used damp with a mixture of alcohol and water at the ratio of 1:1.
Before starting the cleaning process, shut down the device (see section 3.6) and unplug the USB-C power supply **B1**. Only then remove the Baseplate from the drawer to wipe it clean on all sides. In case silica particles from TLC plates, or dust, are on the drawer, or in the housing, both drawer and housing can be cleaned in the same manner – be sure not to touch the illumination unit. Alternatively, the back cover **B7** can be opened (see section 2.2.6), and the dirt inside the device removed by carefully using a hand vacuum cleaner at low power and a tissue.
Please note: Spilled liquid or other material should be removed immediately (see also section 1.2.1)!

10.2 Contact Technical Support

For questions about warranty, warranty related issues, or questions specific to your device, please contact the reseller of your TLC Explorer. Similarly, if in doubt about how to proceed when facing one of the situations listed under 'Do NOT Operate the TLC Explorer if …' in section 1.2.1, please contact the reseller of your device or a local supplier via www.sigmaaldrich.com.
For generic technical questions and software updates (see section 7.2), please visit the official TLC Explorer support site using the link provided in figure 10.1 below.

Figure 10.1: Find the TLC Explorer service page at:
https://sigmaaldrich.com/TLCservice

10.3 Ordering Accessories and Replacement Parts

Currently, the TLC Explorer product portfolio includes the following products which can be ordered separately as additional equipment or replacement parts:

Article Nr.	Name	Description
1.52610.0001	TLC Explorer	TLC Documentation System, including the parts listed in section 3.1 as scope of delivery.
1.52613.0001	Illumination Unit	Replacement part which is only needed in case a light source in your TLC Explorer has broken. The unit houses LEDs and optics for all illumination types, i.e. visible light as well as UV light, and can only be exchanged as a whole.
1.52612.0001	Baseplate	An additional Baseplate can simplify and speed up the workflow, since one Baseplate can be prepared while a second one is recorded in the TLC Explorer (see section 2.3).
1.52611.0001	Power Bank	Powers the TLC Explorer independent of a power grid – e.g. for the use away from a mains power source.
1.52618.0001	Dust Cover	Replacement cover to protect your TLC Explorer against dust.
1.52614.0001	Electronic Unit	The Electronic Unit contains also the camera and PCB.
1.52616.0001	Front Unit	The Front Unit contains the glass-based front including electronical features.
1.52615.0001	Drawer Unit	The Drawer Unit contains all parts to implement the Drawer except a baseplate.
1.52619.0001	Antenna Set	The Antenna Set includes an antenna and a cable set to install and plug the antenna.
1.52630.0001	IQ/OQ Kit for TLC Explorer	The IQ/OQ Kit contains two validated test sheets and documentation paper allowing a device qualification as described in section 5.7.

Common TLC consumables like TLC plates, solvents and stains, as well as tools used in the TLC process (e.g. developing chambers) are available on the website of Sigma Aldrich at www.sigmaaldrich.com.

Figure 10.2: Find TLC consumables and tools at:
https://sigmaaldrich.com

10.4 Replacing the Illumination Unit

The TLC Explorer uses LEDs for illumination, which have a far longer lifetime than traditional light sources. UV emitting LEDs in particular, however, may deteriorate over time, or even fail to function at some point

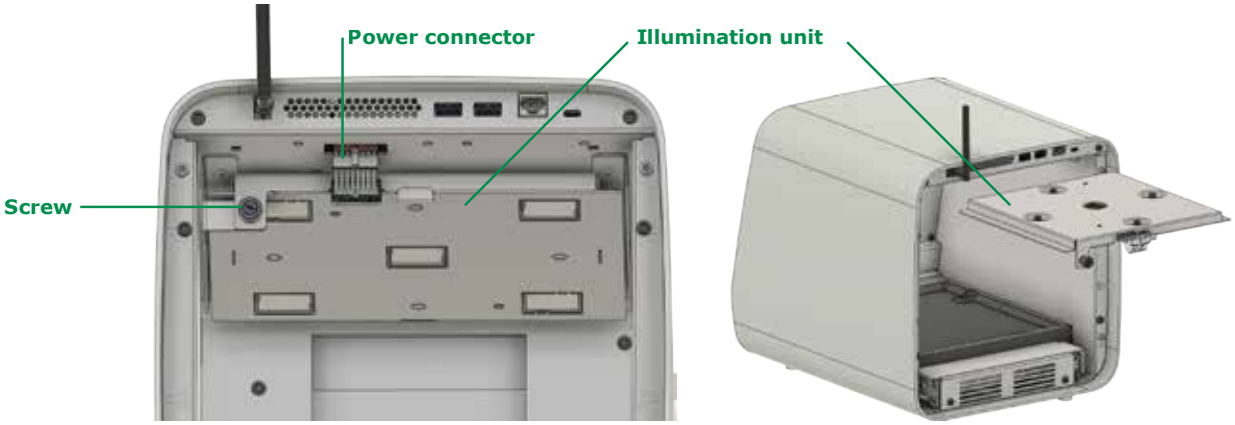


Figure 10.3: Replacing the illumination unit

For safety reasons, the illumination unit (housing the LEDs for all illumination types) can only be replaced as a whole. It is mounted in a rail on top of the measurement chamber. To exchange it, please follow the following procedure:

1) Shut down the device as described in section 3.6.
2) Turn the TLC Explorer so that you are facing its back.
3) Disconnect the device from the power supply by unplugging the USB-C connector **B1**.
4) Remove the back cover **B7** by unscrewing the four screws by hand, or, if needed, with a screwdriver. Please note that the screws are attached to the back cover to avoid losing them.
5) Carefully unplug the cable marked in figure 10.3 as 'Power connector'.
6) Unscrew the fixing screw on the left side of the illumination unit.
7) Pull out the old illumination unit along the rail.
8) Carefully push the new illumination unit along the rail, making sure the unit sits properly in place. Be careful not to touch the glass components, as this can affect the illumination and image recording quality.
9) Retighten the fixing screw and plug in the power connector of the new unit.
10) Remount the back cover and tighten the four screws.

Do not dispose the old illumination unit in unsorted municipal or household waste. Instead, it should either be brought to an official collection and recycling center for electrical and electronic waste or returned to the reseller of your new illumination unit.

10.5 Decommissioning, Storage, and Disposal

If you decide to decommission your TLC Explorer, you can either store it for later use or return it to the reseller or distributor of your TLC Explorer.
There are no batteries in the TLC Explorer. You, therefore, do not need to remove any batteries before storing, shipping or returning the device.
However, there might still be sensitive data on the internal storage. It is strongly recommended to initiate a factory reset (see section 7.5) to remove any user data before decommissioning your TLC Explorer.
The device should also be cleaned of all visible residue and encrusted material. In case the device was in contact with hazardous chemicals or infectious/bio-hazardous materials, it must be decontaminated accordingly. Please note that the reseller can refuse to collect a decommissioned device if it has not been correctly decontaminated.
To store the device, remove any TLC plates and check that no USB stick is plugged in. Do not leave the Baseplate or any accessories inside the housing, but rather pack them separately next to the housing. Ideally, use the original packaging, including the inner packaging, to protect the device while in storage. Ensure that the storage place is dry, with a relative humidity between 20 - 80%, and the temperature remains within a range of 15 - 40 °C.
In accordance with European Union directive 2012/19/UE on the management of waste electrical and electronic equipment (WEEE), **it is strictly forbidden to dispose the TLC Explorer in unsorted municipal or household waste**. Instead, it should either be brought to an official collection and recycling center for electrical and electronic waste or returned to the reseller of your TLC Explorer. For further information on take-back programs offered in your region, please visit https://www.sigmaaldrich.com/EN/en/life-science/quality-and-regulatory-management/recycling.

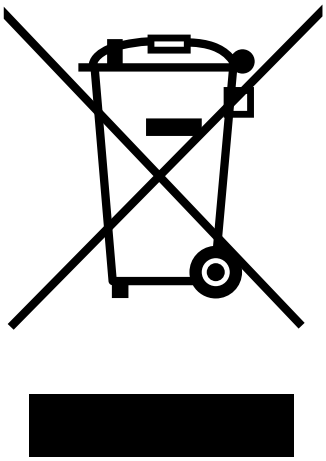


Figure 10.4: Only dispose device at official collection and recycling center or return it to your reseller.

11 Glossary

This glossary focuses on terms, which have a special meaning in the context of the TLC Explorer software. For terms and explanations concerning TLC in general, please refer to section 1.3.

Image Set

An Image Set consists of images captured together (under different illuminations), along with all plate images and data (see 'Evaluations') derived from those. For the software, each Image Set is a separate directory in the user data file system, which becomes apparent when exporting Image Sets from the file manager.
Image sets can only be edited by their owner. If other users wish to work with that data, they can create a copy, which is then owned by them. Changes on the copied Image Set do not affect the original image Set.

Evaluation

'Evaluation' with a capital E refers to a data structure storing settings and results from users working with an Image Set. It is possible to evaluate plate images of an Image Set under different aspects, saving each analysis with its own annotations, track comparisons and/or quantitative analysis as a separate Evaluation.
Each Evaluation includes a copy of the plate images and track data, on which the Evaluation is based. This ensures that later changes in the plate section (e.g. changes to the track data) have no impact on existing Evaluations, but only affect those created afterwards.

Plate and Plate Images

After capturing images under the user selected illumination types, the software automatically detects TLC plates in these images. Identified plates are cropped, rotated to align the bottom edge horizontally, and then saved as separate image files. Images of the same plate under different illumination types are stored together in a subdirectory of the image Set.
At the 'Plate' page of the user interface (see section 4.6), you can add meta data to each plate and define track positions and properties. All further processing steps, like the calculation of densitograms or spot measures, are based on plate image files.

Illumination

The drop-down menu 'Illumination' lets you choose the plate image of a selected plate, which was taken under the desired illumination type (e.g. visible light, UV-A or UV-C; for details see section 2.1.2).
Plate images that have been modified and then saved at the 'Plate' page, e.g. with enhanced contrast, appear as additional entry at the 'Illumination' drop-down menu, and can be used for processing just like the original plate images.

Track Baseline and Densitogram Baseline

The term 'baseline' can refer either

- to the starting line, on which samples are spotted on a TLC plate, or
- the base of a densitogram.

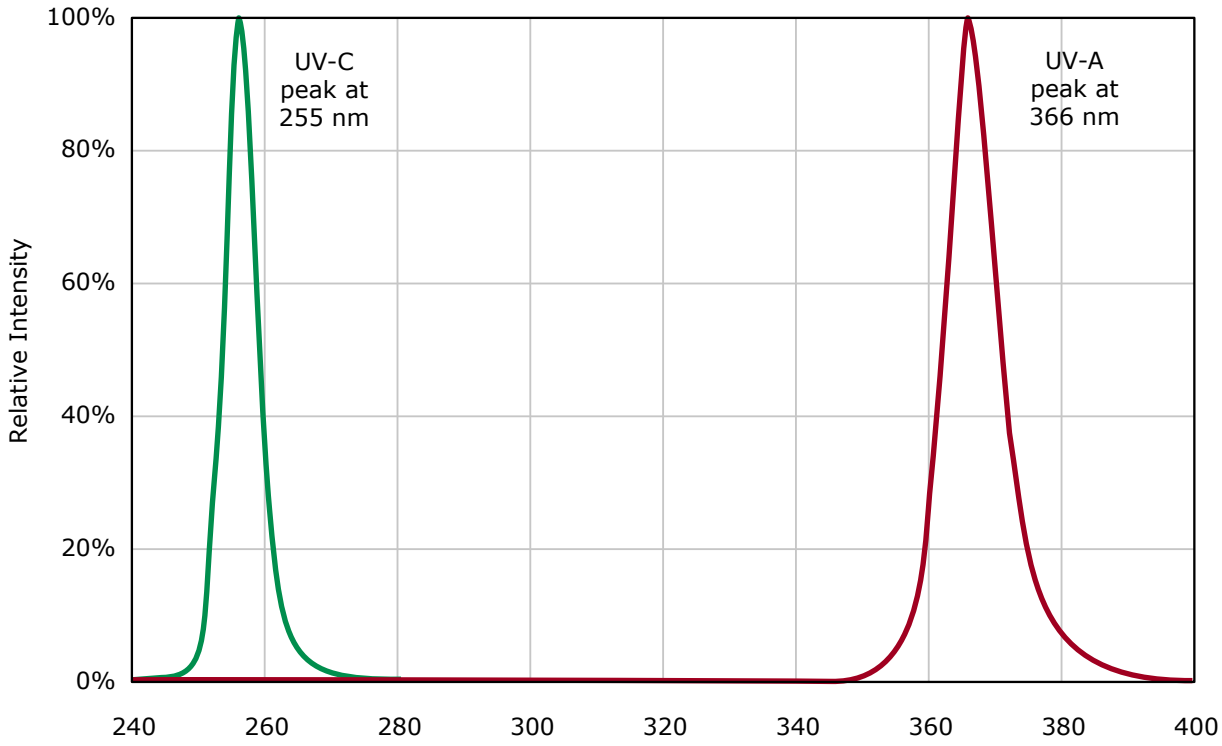
While the track baseline is the origin of the (h)R_f scale of that track, the densitogram baseline can be automatically subtracted for plotting or compensated manually by setting an offset.

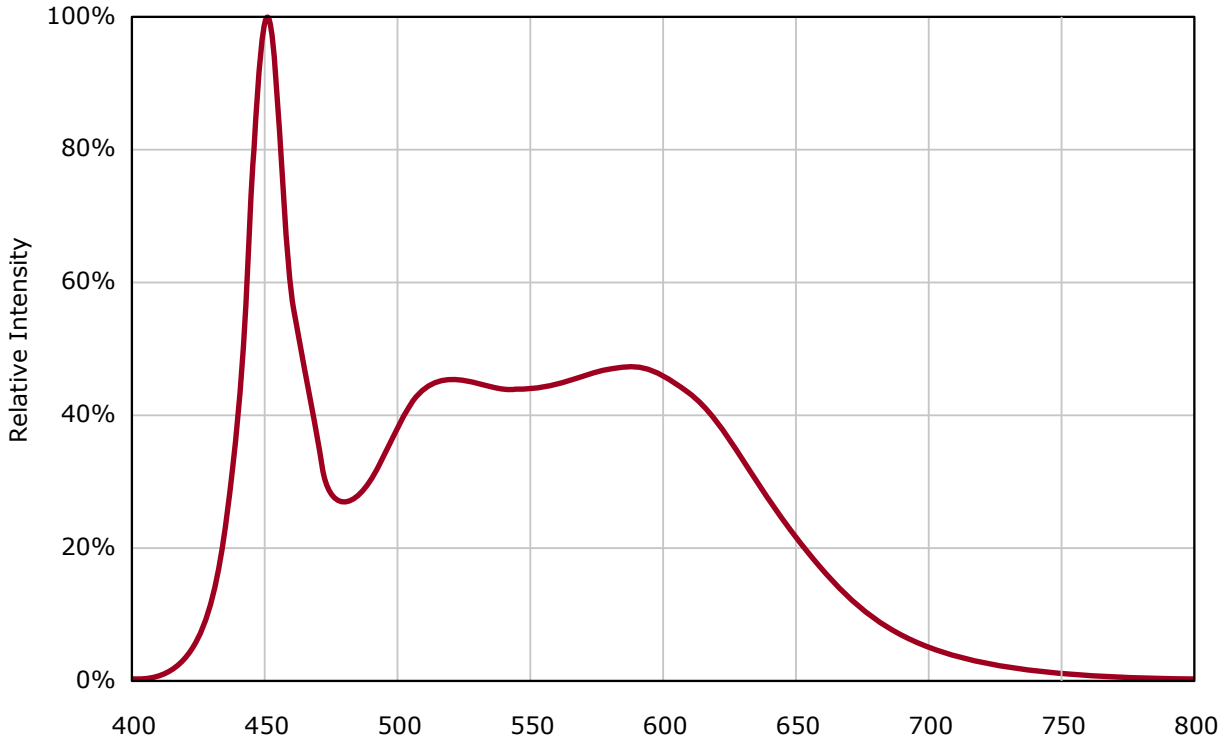
12 Technical Data

12.1 Device measurements and specifications

(External) Power supply	USB-C Power Supply Unit / 65 W
Power supply	External Power Supply Unit (HA65NM170) is provided with separate Power supply cord(s) (1.8 m long) fitting type B, G, N, I, D, E/F plugs (the plug must comply with local regulations)
Power requirements	100 V - 240 V, 50 - 60 Hz for the external power supply Unit
Power consumption	Standard working condition: 18.8 W; standby mode: 0.83 W
Measuring technology	Documentation system for TLC plates by using video densitometric measurement
Wavelength range	The TLC Explorer provides the standard illumination for detecting TLC plates (see also section 12.2): • Visible light (VIS) • UV-C - WL: 254nm • UV-A – WL: 366nm
Camera	RGB sensor with 3280 × 2464 active pixels; one pixel captures an area of approx. 85 × 85 µm on TLC plate
Communication interfaces	• USB: 2 × USB-A (for directly connecting of an USB Stick) • Ethernet: LAN • WLAN IEEE 802.11 b/g/n (2.4 GHz)
Protection (IP) class	IP2X (for the main enclosure)
Ambient condition: Temperature	• The device can be operating in a temperature range from 15 °C to 40 °C. • The temperature for storage and transportation should be between 5 °C and 40 °C.
Ambient condition: Relative humidity	• The device can be operating in a humidity range from 20%RH to 80%RH, non-condensing conditions shall be ensured • The humidity for storage and transportation should be in a range from 15%RH to 95%RH, non-condensing conditions shall be ensured
Ambient condition: Altitude	< 2000 m
Dimensions	374 x 312 x 290 mm length x width x height
TLC plates sizes	Usage of TLC plates with a size of 20 cm x 20 cm and smaller
Weight	approx. 10.4 kg
Instrument safety	Complies with Low voltage Directive 2014/35/EU IEC 61010-1, ANSI/UL EN 61010-1 CSA-C22.2 No. 61010-1-12
EMC	Complies with EMC Directive 2014/30/EU EN/IEC 61326-1 / EN 301 489-1 FCC
RF	Complies with RED 2014/53/EU EN 300 328, FCC Contains: FCC ID 2ABCB-RPICM4 IC:20953-RPICM4

12.2 Illumination spectra





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