METER

HYPROP-VARIOS CONNECTOR APPLICATION NOTE

HOW TO MEASURE SOIL WATER TENSION, WATER CONTENT, AND THERMAL CONDUCTIVITY IN ONE SOIL SAMPLE

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1. INTRODUCTION

Thank you for choosing HYPROP 3 and VARIOS from METER Group. The HYPROP-VARIOS Connector will optimize use of the HYPROP and VARIOS systems. This application note includes information for using the HYPROP-VARIOS Connector for multiple measurements from one soil sample as well as soil sample preparation, measuring, and postprocessing information.

Also included in this application note are LABROS SoilView Software configuration instructions and LABROS SoilView-Analysis evaluation steps. Complete user manuals for LABROS SoilView and SoilView-Analysis, and both devices are available on the METER website HYPROP 3 (meter.ly/hyprop-support) and VARIOS (meter.ly/varios-support) support pages.

HYPROP is a measuring system for water retention function and hydraulic conductivity as a function of the water tension and water content of soil samples.

VARIOS is an automated measurement and evaluation lab system for determining thermal conductivity as a function of water content of soil samples and other materials.

HYPROP-VARIOS Connector is a toolset for combining both measurement systems and enabling the determination and evaluation of all parameters on one soil sample at the same time.

METER Group GmbH offers a warranty for material and production defects for these accessories in accordance with locally applicable legal provisions for a maximum of 12 months. The warranty does not cover damage caused by misuse, unauthorized servicing, or circumstances beyond METER's control. The warranty includes replacement or repair and packing but excludes shipping expenses. Please contact METER or our representative before returning equipment. Place of fulfillment is Mettlacher Straße 8, Munich, Germany.

HYPROP-VARIOS CONNECTOR SET

Prior to use, verify the items arrived in good condition.

- 1 HYPROP auger guide with marking
- 1 VARIOS installation tool
- 1 soil sampling ring lid with intentional cut

The HYPROP-VARIOS Connector set provides all the equipment needed to combine HYPROP and VARIOS measurements. Please note that the devices and accessories needed for HYPROP and VARIOS measurements are included in the respective sets of the devices. Please refer to the HYPROP User Manual (meter.ly/hyprop-um)and the VARIOS User Manual (meter.ly/varios-um)for correct device and accessory use.

2. OPERATION

Please read all instructions before operating the HYPROP and the VARIOS to ensure it performs to its full potential.

⚠ PRECAUTION

METER sensors are built to the highest standards, but misuse, improper protection, or improper installation may damage the sensor and possibly void the manufacturer's warranty. Before integrating HYPROP 3 and VARIOS into a system, make sure to follow the recommended installation instructions and have the proper protections in place to safeguard sensors from damage.

Please observe the following considerations carefully:

1. Read all applicable safety instructions.
2. Electrical installations must follow the safety and EMC requirements of the country where the system is used.

   IMPORTANT: Do not use the device if the electrical wire is damaged. Always avoid direct sunlight exposure.
3. Dispose of all materials and chemicals according to national legislation and environmental care regulations.

   Please refer to the respective safety data sheets.
4. Do not touch the ceramic tips of the tensiometer shafts with bare hands.

   Grease or soap reduces the hydrophilic characteristics of the ceramic.
5. Do not stick sharp objects into the holes of the sensor unit.

   This may damage the pressure sensors.

2.1 INSTALLATION

Follow the steps listed below to set up HYPROP and VARIOS and start collecting data.

Tools needed

• Microsoft Windows computer (Windows 10 or newer)

• LABROS software with METER USB driver

1. Download the installation package (LABROS SoilView software) from the METER website either support page: HYPROP 3 (meter.ly/hyprop-support), or VARIOS (meter.ly/varios-support).

   NOTE: The combination measurement is only possible with software version 5.2.0 and higher.
2. Run the LABROS SoilView *.exe file and follow the instructions on the installation assistant screen.

   Default settings will simultaneously install both the software LABROS SoilView (measurement software) and LABROS SoilView-Analysis (evaluation software) (see Figure 1). If only one software package is desired, please select `Entire feature will be unavailable` in the window for the software that is not needed (Figure 2).

After LABROS SoilView is install the installation Wizard will automatically install the METER USB driver.

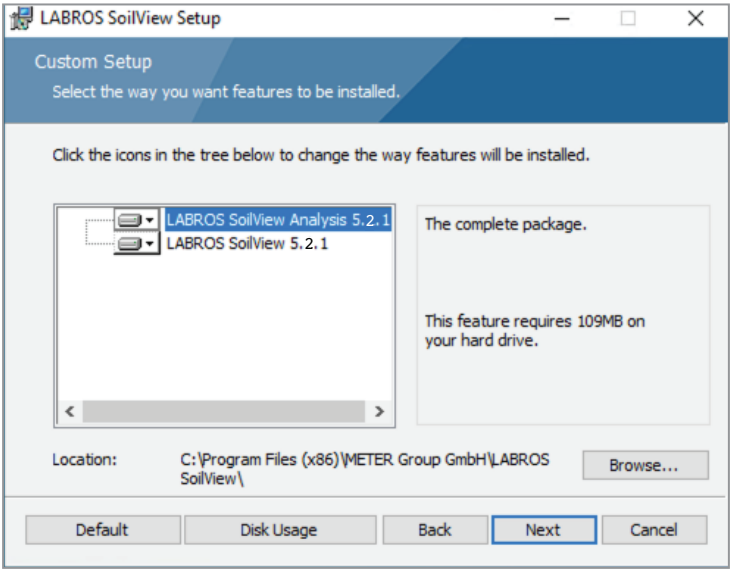


Figure 1 Installation

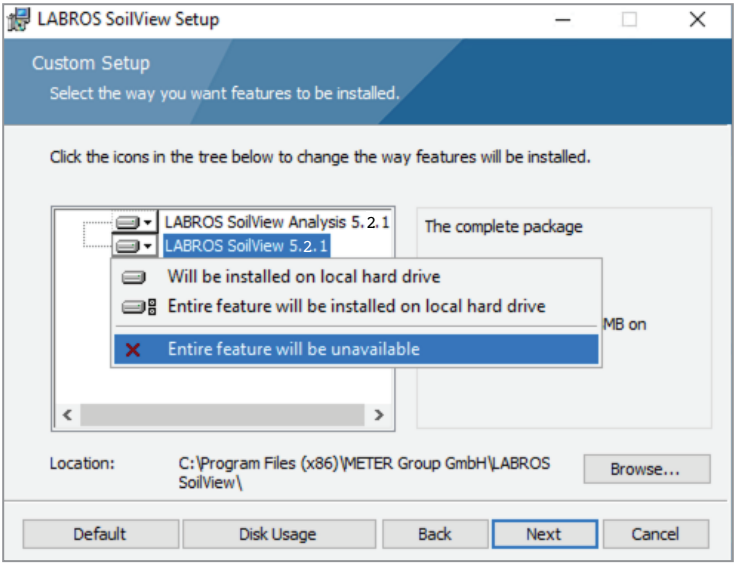


Figure 2 Installation options

CUSTOM SETUP SCREEN

If there is a problem executing the file LABROS.exe, please download and install Microsoft NET Framework 4.8 manually and be sure to have the current version of the Windows installer.

3. Click on the LABROS SoilView software icon to open the program.

   The icon is located where saved in the Wizard installation.

4. Consider surroundings and place the Balance on a horizontal, vibration-free, solid surface where the temperature remains relatively stable (away from the air conditioner and heater vents, windows, etc.).

IMPORTANT: Temperature fluctuations or vibrations will strongly affect the accuracy of the measurement results.

⚠ WARNING

VARIOS and HYPROP are not intended for outdoor use.

2.2 PREPARE SOIL SAMPLE

There are two methods for preparing a soil sample: disturbed and undisturbed. Undisturbed must be done at the collection sight.

Soil sample preparation is the same for the HYPROP and the VARIOS, except that the VARIOS ring has the sensor needle hole that needs covered. In both methods of soil sample preparation, it is important that the sample ring is full, and the soil surface is flush (planar) with the top and bottom of the sample ring. All calculations are based on the exact volume of the sample ring.

For detailed soil sample preparation directions, please refer to section 2.4 in the VARIOS User Manual or section 2.3 in the HYPROP 3 User Manual.

2.3 SATURATE SOIL SAMPLE

Follow the steps in this section to properly saturate disturbed or undisturbed soil samples.

Gather the tools needed for saturation:

- Large filter paper
- Small filter paper
- 2 LABROS saturation plates
- Weight
- Tray
- Tap water at room temperature

1. Take the soil sample out of the refrigerator.
2. Remove the cover on the cutting side of the sample ring. If soil material is protruding above the top of the sample ring, cut off the protruding material until the surface is flush (planar) with the top of the sample ring. Cut a little bit at a time along the edge of the sample ring, and be careful not to smudge the surface and close the pores (Figure 3).

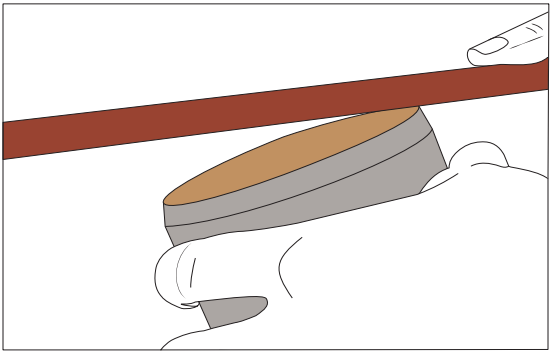


Figure 3 Cut protruding material level with top of sample ring

3. Examine the cutting side for irregularities such as big stones, pebbles, woody debris, roots, and intense smell.
4. Estimate the possible lack of volume in mL attributed to the space taken up by irregularities identified in step 3.
5. Enter the volume in mL under the Information tab in the LABROS SoilView-Analysis software (Figure 4). The volume will affect the calculations that are based on the assumed 250 cm3 volume.

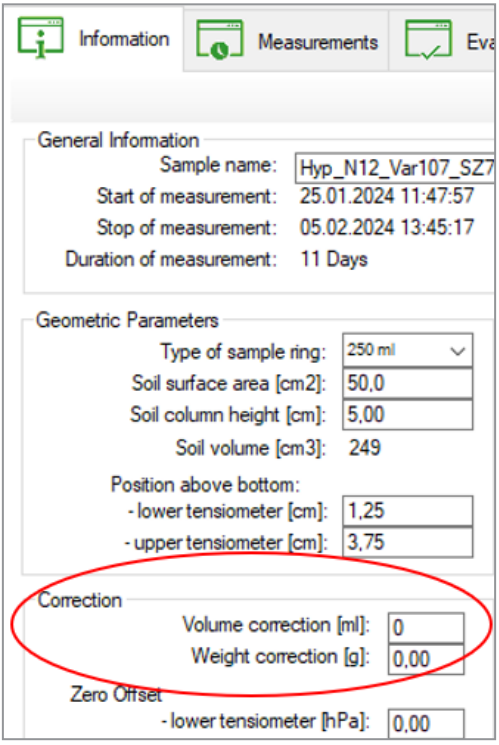


Figure 4 Enter volume zero

6. Place one of the large filter papers on the cutting side of the sample ring.
7. Place a LABROS saturation plate on the cutting side of the sample ring.

   NOTE: The sample ring should fit snugly in the LABROS saturation plate.
8. Hold the filter paper and LABROS saturation plate together and turn the sample ring over so the cutting side faces down (Figure 5).

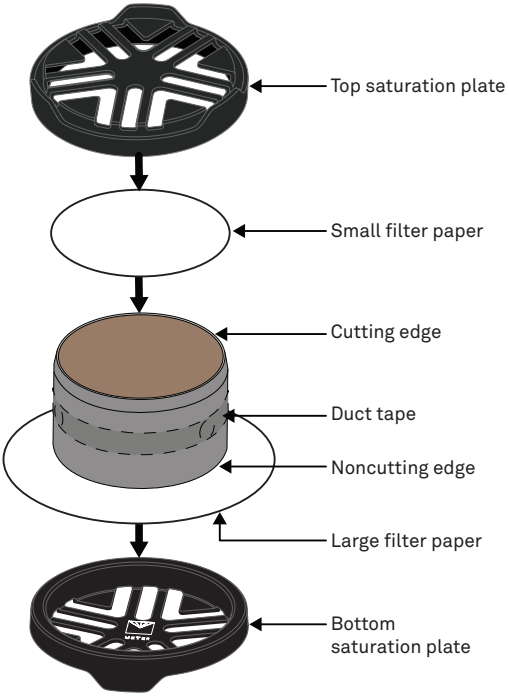


Figure 5 Sample setup

9. Remove the cover of the noncutting side of the sample ring.
10. Repeat step 3 to 5 for the noncutting side.
11. Place one of the small filter papers on the noncutting side of the sample ring.
12. Place the sample ring in a tray.
13. Fill the tray with about 3 cm of room-temperature tap water.
14. Tilt the LABROS saturation plate carefully to every side to remove air bubbles.

15. Let the sample pull the water from the bottom to the top.
16. It is important to let the sample saturate through capillary action. Do not pour water on the top of the sample because air enclosures and the pores will not completely fill with water (Figure 6).
17. Store the trough and the soil samples where they are not directly exposed to sunlight.
18. In case the material swells as it takes in water, place a weight on top of the sample to keep it from floating or tipping.
19. Saturation is finished when the surface of the sample is glossy.

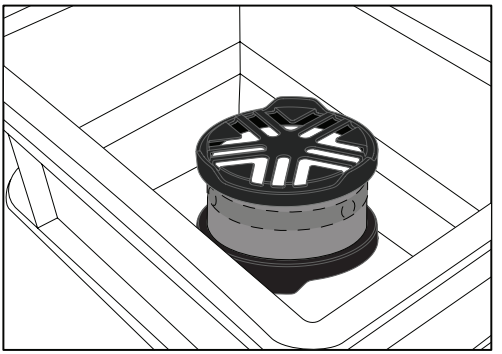


Figure 6 Soil sample in water trough

2.4 DEVICE PREPARATION

The HYPROP sensor unit and its tensiometer shafts need careful preparation. Detailed directions for preparing the tensiometer shafts and HYPROP sensor unit are available in the HYPROP User Manual section 2.5.

2.4.1 INSERT SENSOR NEEDLE INTO SAMPLE MATERIAL

NOTE: For a combined HYPROP and VARIOS measurement of soil samples, only the TC-S70 sensor needle can be used. This sensor comes as default with the VARIOS Complete Set and VARIOS Extension Set.

METER designed the VARIOS sensor to be easy to install and use. The sensor needle must be inserted all the way into the sample material. Please observe the following considerations when installing the sensor.

- Ensure there is a minimum of 1.5 cm of material surrounding the sensor needle in all directions to avoid errors.
- Ensure there are no gaps around the sensor needle.
- Insert the sensor needle all the way into the sample material.

⚠ CAUTION

Bending the needle can damage any sensor beyond repair. If the needle becomes bent, gently bend it back. A replacement may be needed if a needle is bent and no longer taking good readings. Contact Customer Support for a replacement.

Below is a list of tools needed to install and secure the sensor in the soil sample:

- Installation tool
- Sensor with a TC-S70 needle
- 2 or more retaining rings
- Cut sample ring lid

Using the tools listed above, please follow the steps below to insert the sensor needle into the soil sample.

1. Take saturated sample out of the tray.
2. Remove the upper saturation plate and filter paper.
3. Clean any soil and water off of the sample ring.
4. Cover the sample ring with the cut sample ring lid from the combination set (Figure 7).

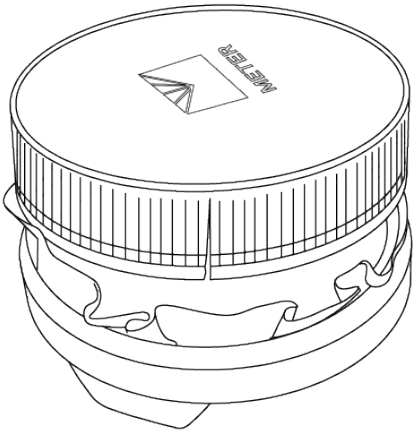


Figure 7 Cut soil sampling ring lid

5. Turn the setup around and place it in the installation tool (Figure 8).
   Use just the upper part of the installation tool.

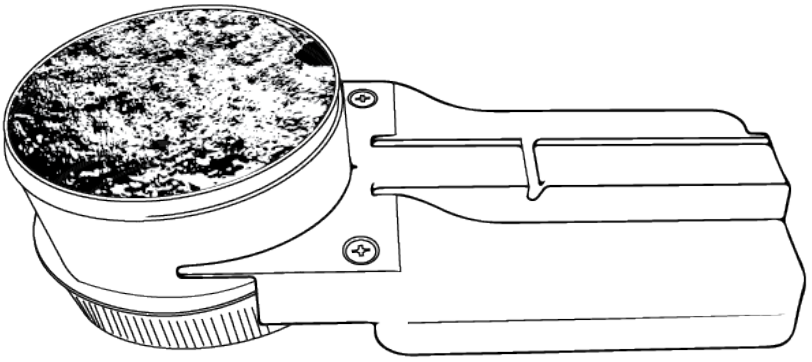


Figure 8 Soil sampling ring on installation tool

6. If a KSAT measurement has been taken before, the KSAT red gasket sets the sample higher and both tool parts must be used to reach the correct height (Figure 9).

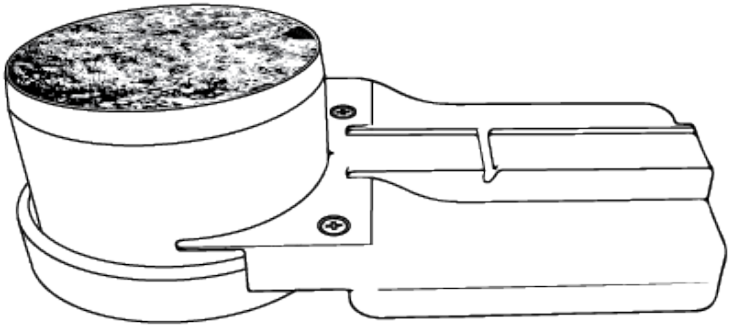


Figure 9 Soil sampling ring on installation tool after KSAT measurement

7. Align one of the soil sample ring drill holes with the installation tool guide rail (Figure 8).
8. Place a retaining ring around the sample ring and into the notch of the installation tool (Figure 10).
9. Place the sensor on the installation tool guide rail (Figure 10).

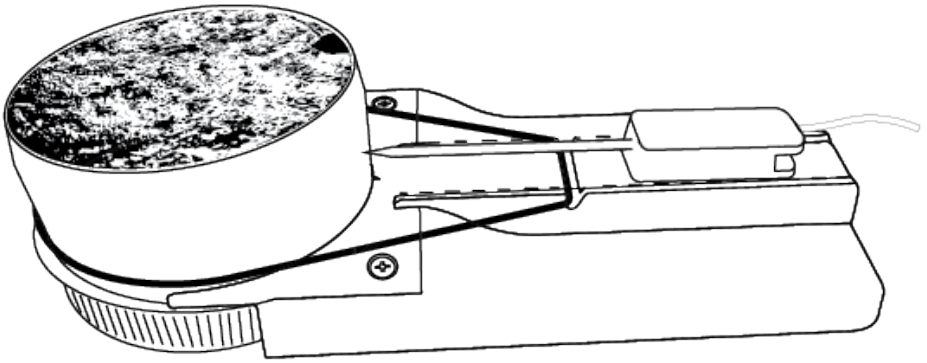


Figure 10 Sensor on installation tool

10. Insert the sensor needle continuously into the soil sample through the duct tape with even pressure by pushing it forward on the installation tool guide rail.

    NOTE: Avoid movements that will cause the needle to wobble as it is inserted. Secure the installed needle using several retaining rings to prevent the needle from changing positions. If the needle slides around inside the soil sample, air gaps may form that will cause a significant error in the measurement readings. Note: If the sensor cannot be installed because of an irregular object such as a stone, try to install it using the second drilling hole.

11. Secure the sensor in place by positioning the retaining ring in the lower notch of the sensor hull (Figure 11).
12. Use a second retaining ring to secure the sensor by placing the retaining ring around the sample ring and positioning it in the upper notch of the sensor hull (Figure 11).

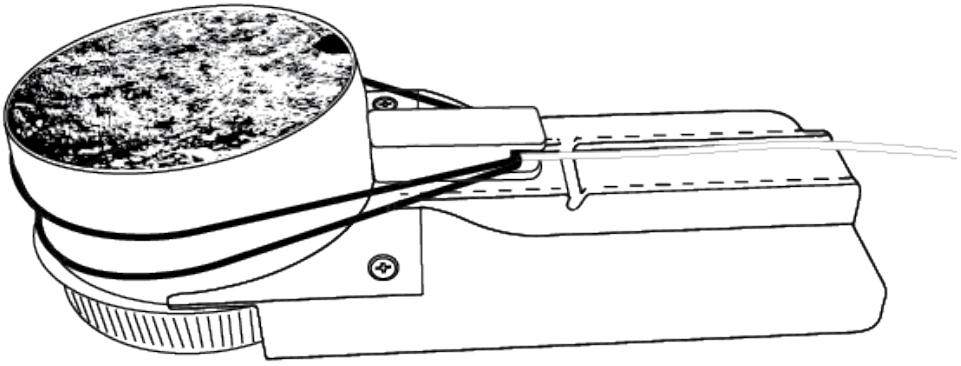


Figure 11 Sensor secured to sample ring on installation tool

13. Secure the sensor cable connector in the retaining rings (Figure 12).
14. Remove the installation tool.

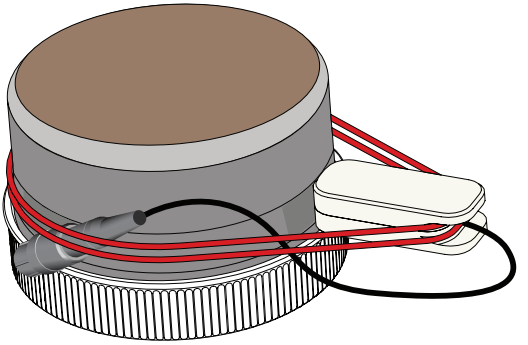


Figure 12 Soil sampling ring with sensor installed

2.4.2 INSTALL HYPROP SENSOR UNIT AND SOIL SAMPLE

To assemble the HYPROP sensor unit and soil sample, you will need the following equipment:

- Hand auger for tensiometer shafts
- Drilling adapter with marking
- Syringe with water
- Paper towel

Complete the steps below to assemble the HYPROP sensor unit and soil sample:

1. Place the drilling adapter on the cutting edge of the soil sample.
2. Align the marking of the drilling adapter with the middle of the sensor needle hull (Figure 13).

   Be sure that the adapter is not placed askew.

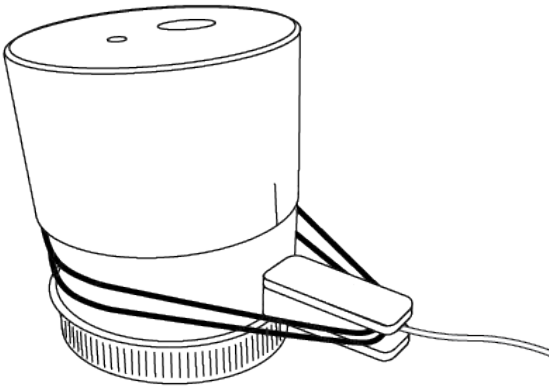


Figure 13 Align marked drilling adapter on soil sample

3. Use the hand auger to drill both tensiometer shaft holes in the soil sample (Figure 14).

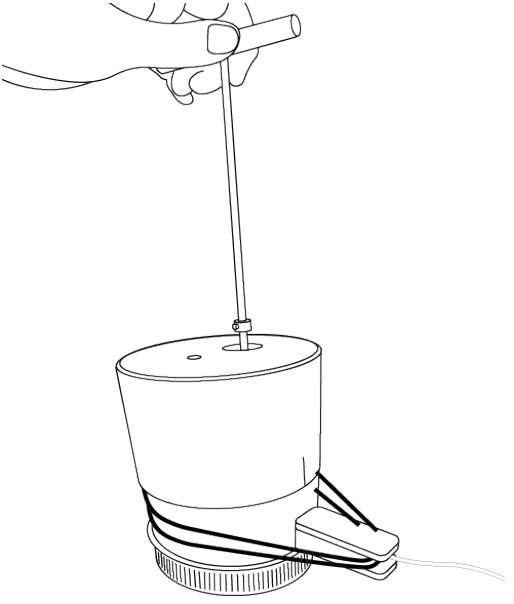


Figure 14 Drilling the holes

4. Drill the long hole in three steps and the small hole in two steps to avoid compressing the soil.

   The material of the holes does not have to be weighed or stored as this volume is automatically mentioned as a subtracted volume in the evaluation.

   IMPORTANT: Before removing the drilling adapter, note and remember which is the hole for the long shaft and which is for the short shaft.

5. Take off the drilling adapter and fill the holes with water out of the syringe to ensure no air will be pressed into the soil sample while assembling.
6. Place the HYPROP sensor unit carefully upside down onto the cutting-edge of the soil sampling ring.
7. Place the tensiometer shafts cautiously in the correct hole while being careful not to compress the soil (Figure 15).

Figure 15 Assembling the HYPROP unit

8. Turn the whole setup around.

   Be careful not to move the sensor needle.
9. Remove the lid, and fix the soil sampling ring with the clips.

   Avoid evaporation before measuring by placing a wet filter paper on top of the sample.
10. Clean and dry the soil sampling ring and the clips with a paper towel or a brush. Otherwise, water and dirt will be weighed too (Figure 16).

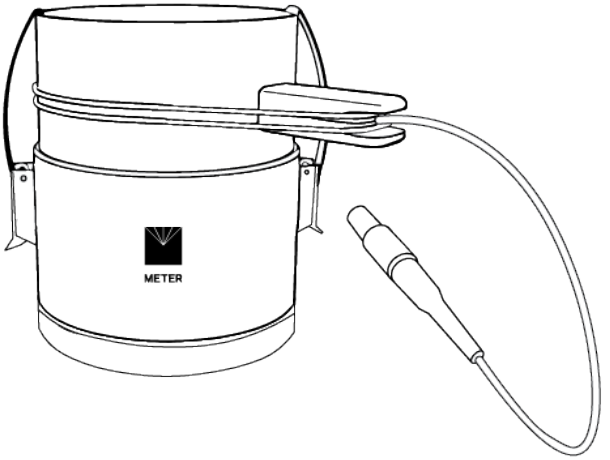


Figure 16 Fix and clean the soil sampling ring

The soil sample is now ready to be measured.

2.4.3 LABROS BALANCE

Prepare the LABROS Balance by first

1. Positioning the measurement pan on top
2. Leveling the Balance
3. Connecting the AC adapter for power
4. Connecting the Balance to a computer with USB cable

Additional instruction and information on the LABROS Balance is available on the HYPROP support page and in the LABROS Balance User Manual (meter.ly/labros-balance-um). For detailed preparation of the LABROS Balance for measurement, please refer to the HYPROP User Manual, section 2.5.7.

3. MEASUREMENT WITH LABROS SOILVIEW SOFTWARE

Running a combined HYPROP and VARIOS measurement is only possible with HYPROP Multi Balance Mode (HYPROP User Manual section 2.6.1) and VARIOS thermal dryout configuration (VARIOS User Manual section 2.3.1).

3.1 CONNECTING DEVICES TO A COMPUTER

Follow the steps below to connect the VARIOS and the HYPROP for a combined measurement.

1. Place the LABROS Balance on a stable surface.

   It is also possible to use a HYPROP Balance (VARIOS ready) or a HYPROP Balance with a VARIOS power adapter. For more information about the balance options and connection instructions, please refer to the VARIOS User Manual sections 1.4 and 2.3.1.2.

2. Remove the Balance plate.
3. Place the VARIOS on top of the Balance.
4. Plug the VARIOS connection cable on the back of the VARIOS into the connector (Figure 17).

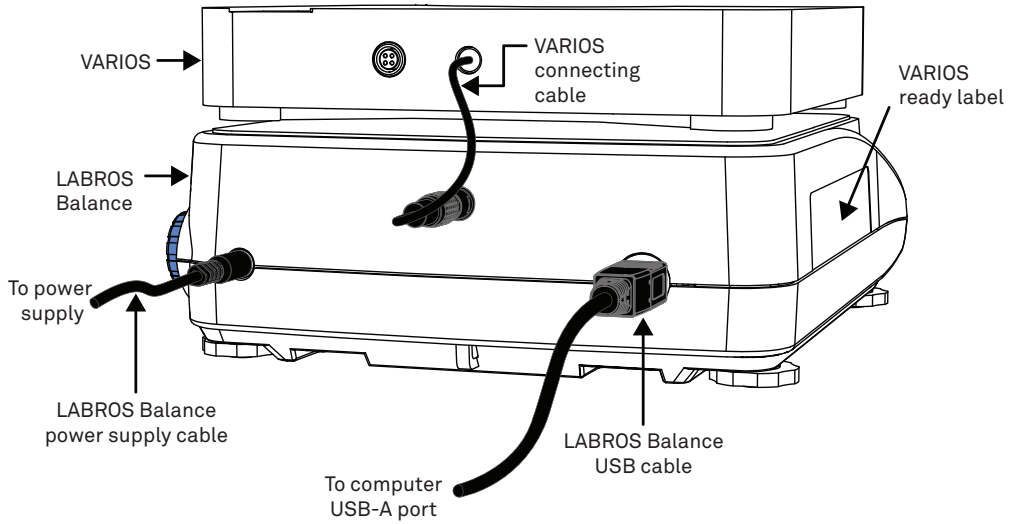


Figure 17 VARIOS setup for thermal dryout configuation back view

5. Plug the USB-B connector to the back of the Balance and the USB-A connector to the computer.
6. Turn on the Balance.
7. Place the HYPROP Magnet cable on the marked spot on the VARIOS and connect it to the VARIOS as shown in Figure 18 and Figure 19

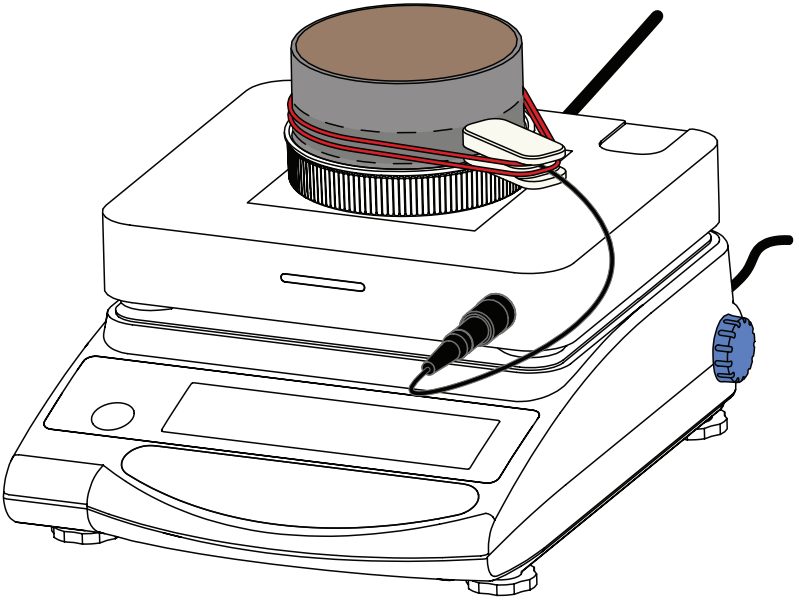


Figure 18 Magnet cable placed on VARIOS

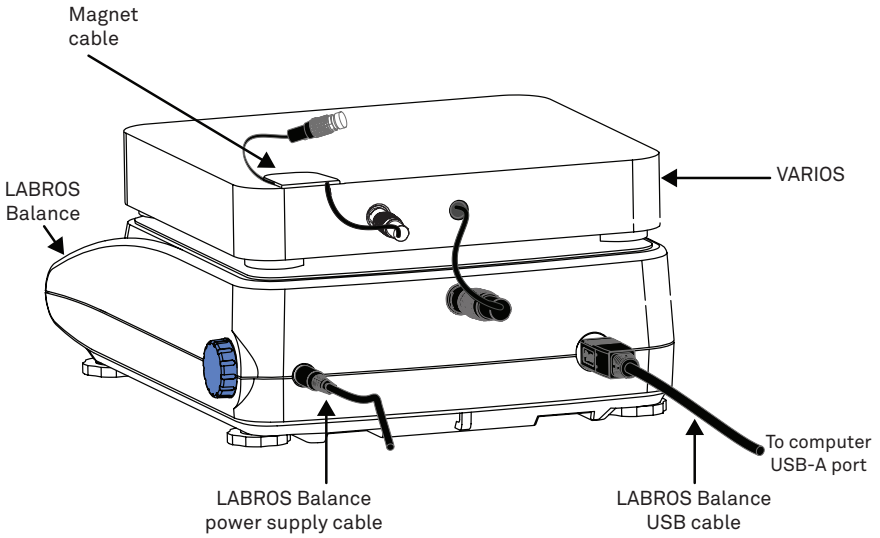


Figure 19 Magnet cable connected VARIOS

8. Tare the Balance, including the magnet cable.
9. Place the HYPROP sensor unit in the middle of the circle on the Balance and connect it to the magnet cable (Figure 20).

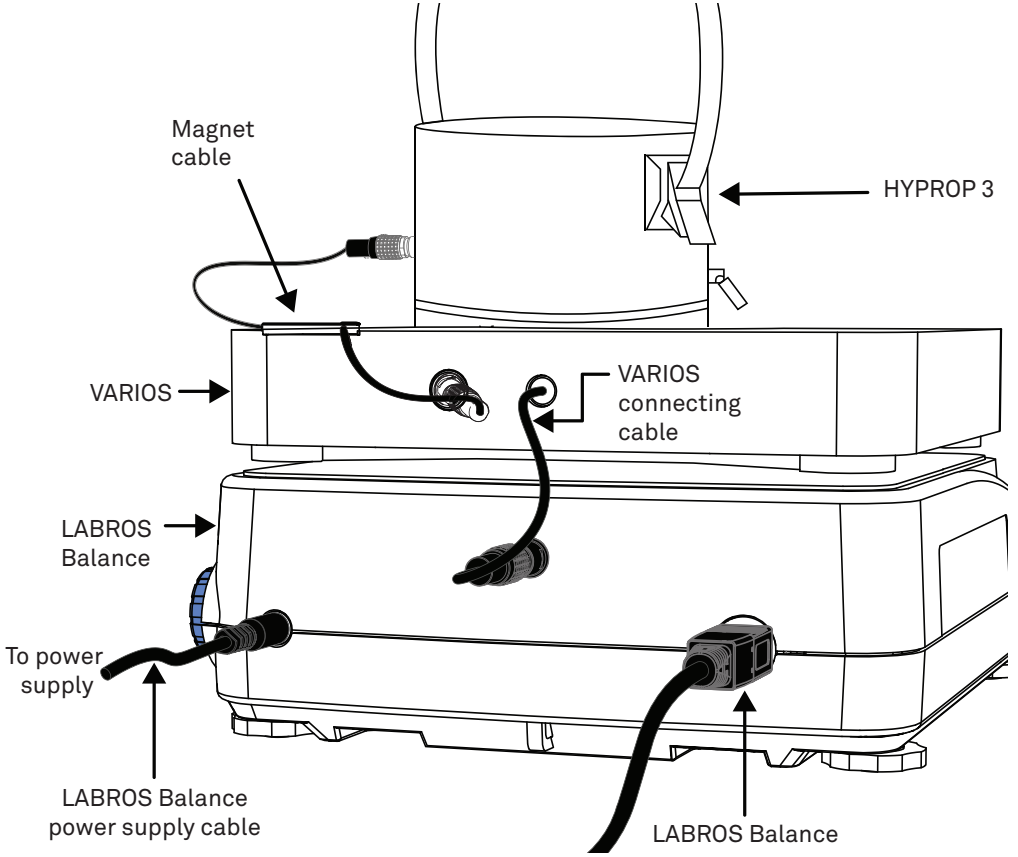


Figure 20 Connecting HYPROP sensor unit

10. Repeat step 1 through step 9 for every balance and sensor unit used.

    NOTE: This method is tested for a maximum of 20 balances and sensor units (10 sensor units per USB hub).

11. LABROS SoilView software automatically displays all connected balances and sensor units on the left side of the software screen (Figure 21).

    If not, check if the balances are turned on and all connected HYPROP and VARIOS sensor units have individual device IDs.

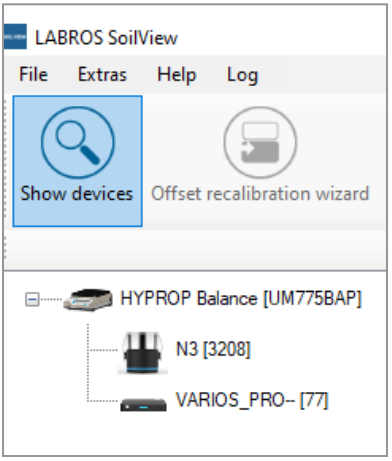


Figure 21 Connected devices

3.2 CONFIGURE AND START THE MEASUREMENT

1. Enter sample name and storage location in the line showing the HYPROP-VARIOS soil sample to be measured (Figure 22).

   The Balance is automatically detected. Weight measurements are entered here for empty soil sampling ring, silicone retaining ring, and sample ring lid. Weights can be entered before or after the measurement is complete using the LABROS SoilView-analysis software.

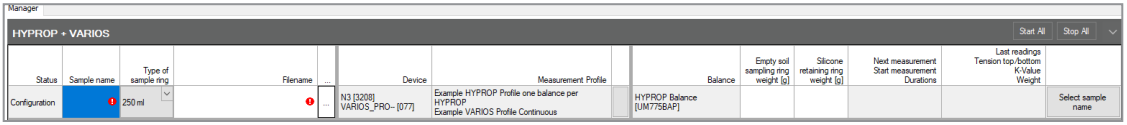


Figure 22 Start manager

2. Adapt HYPROP and VARIOS measurement profiles by selecting the button marked in Figure 23.

   For more information about the measurement profiles, refer to section 2.6.4 in the HYPROP User Manual and section 2.7.4.1 in the VARIOS User Manual.

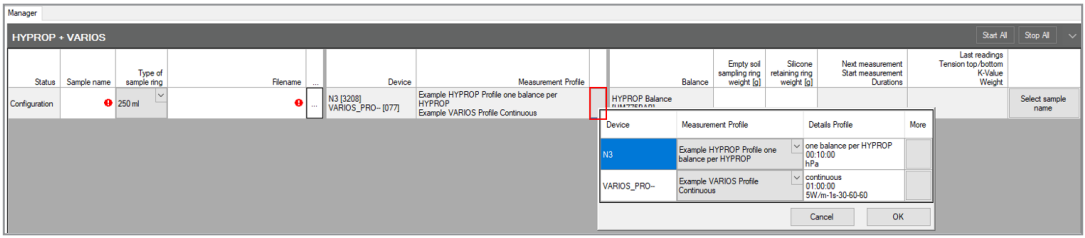


Figure 23 Measurement profiles button

For a combined HYPROP and VARIOS measurement there are some recommended limitations in VARIOS settings (Table 1):

Table 1 Parameter limit recommendations

Parameter	Minimum	Maximum
Heater power	1 W/m	8 W/m0
Measurement interval	1 h	12 h
Added time of sampling interval and number of heat samples	30 s	200 s

3. Select `Start` to start the measurement.
4. Remove the lid and the nonwoven cloth.
5. Dry the soil sampling ring carefully with a paper towel.
6. Repeat step 1 through step 5 for all samples to be measured.

   Using the manager, it is possible to configure all measurements and start them all simultaneously using the button `Start All` (Figure 24).

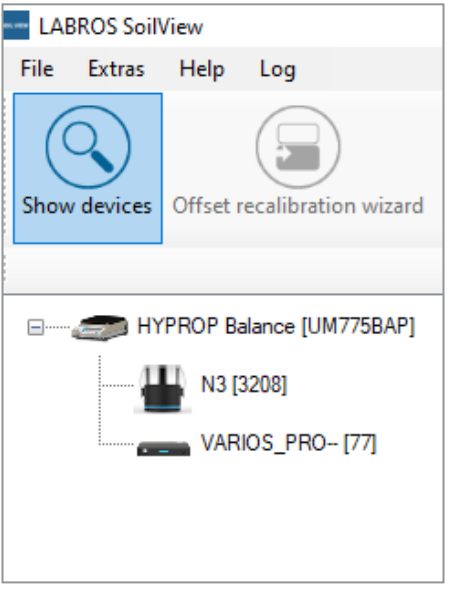
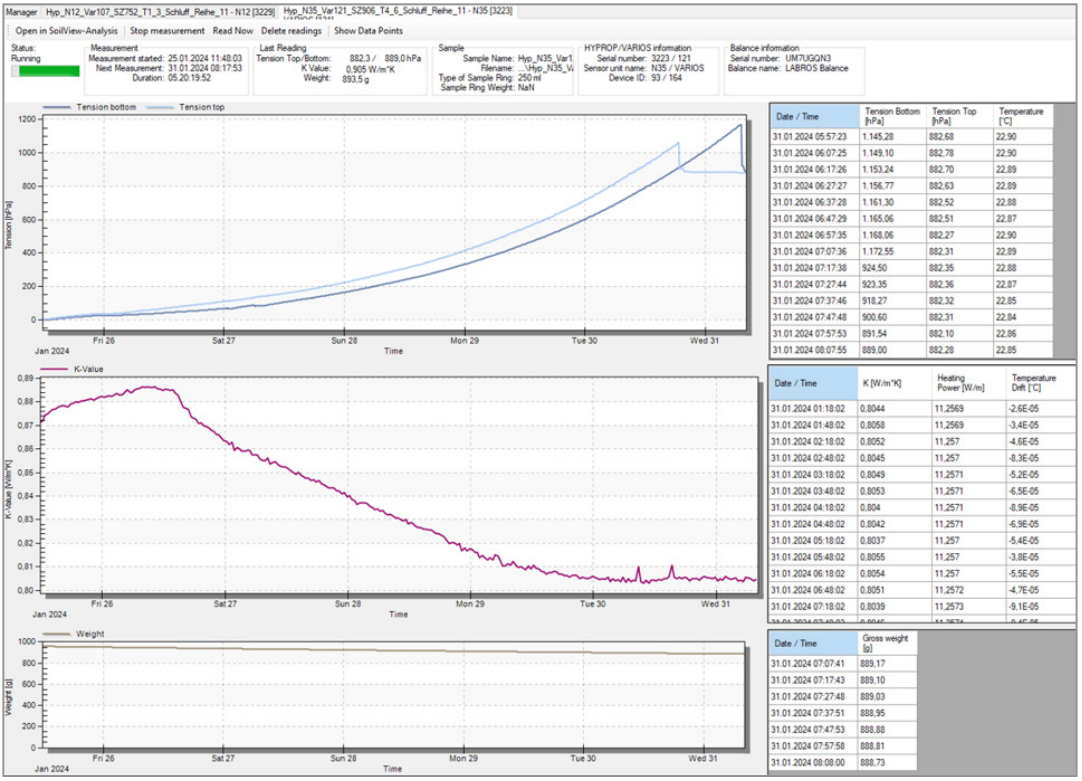


Figure 24 Connected devices

7. Leave the measurement system undisturbed in an area free of vents, windows, or foot traffic that could bump or shake the sensor units.

   The measurement tab shows (Figure 25):

   - soil water tension values, measured with the HYPROP
   - thermal conductivity values, measured with the VARIOS
   - weight change, measured with LABROS Balance



Date / Time	Tension Bottom [hPa]	Tension Top [hPa]	Temperature [°C]
31.01.2024 05:57:23	1.145,28	882,68	22,90
31.01.2024 06:07:25	1.149,10	882,78	22,90
31.01.2024 06:17:26	1.153,24	882,70	22,89
31.01.2024 06:27:27	1.156,77	882,63	22,89
31.01.2024 06:37:28	1.161,30	882,52	22,88
31.01.2024 06:47:29	1.165,06	882,51	22,87
31.01.2024 06:57:35	1.168,06	882,27	22,90
31.01.2024 07:07:36	1.172,55	882,31	22,89
31.01.2024 07:17:38	924,50	882,35	22,88
31.01.2024 07:27:44	923,35	882,36	22,87
31.01.2024 07:37:46	918,27	882,32	22,85
31.01.2024 07:47:48	900,60	882,31	22,84
31.01.2024 07:57:53	891,54	882,10	22,86
31.01.2024 08:07:55	889,00	882,28	22,85

Date / Time	K [W/m*K]	Heating Power [W/m]	Temperature Diff. [°C]
31.01.2024 01:18:02	0,8044	11,2569	-2,6E-05
31.01.2024 01:48:02	0,8058	11,2569	-3,4E-05
31.01.2024 02:18:02	0,8052	11,257	-4,6E-05
31.01.2024 02:48:02	0,8045	11,257	-8,3E-05
31.01.2024 03:18:02	0,8049	11,2571	-5,2E-05
31.01.2024 03:48:02	0,8053	11,2571	-6,5E-05
31.01.2024 04:18:02	0,804	11,2571	-8,9E-05
31.01.2024 04:48:02	0,8042	11,2571	-6,9E-05
31.01.2024 05:18:02	0,8037	11,257	-5,4E-05
31.01.2024 05:48:02	0,8055	11,257	-3,8E-05
31.01.2024 06:18:02	0,8054	11,257	-5,5E-05
31.01.2024 06:48:02	0,8051	11,2572	-4,7E-05
31.01.2024 07:18:02	0,8039	11,2573	-9,1E-05

Date / Time	Gross weight [g]
31.01.2024 07:07:41	889,17
31.01.2024 07:17:43	889,10
31.01.2024 07:27:48	889,03
31.01.2024 07:37:51	888,95
31.01.2024 07:47:53	888,88
31.01.2024 07:57:58	888,81
31.01.2024 08:08:00	888,73

Figure 25 Measurement tab

Soil weight, soil water tension, and thermal conductivity values will be recorded automatically in a defined frequency (settings) until the measurement is stopped. See HYPROP User Manual section 2.6.7 and VARIOS User Manual section 2.7.5.2 for instructions on how to stop measurements.

NOTE: Running a combined HYPROP and VARIOS measurement, both measurements have to be stopped at the same time.

3.3 POSTPROCESSING A MEASUREMENT

After measurement, the weight of the dry soil of the sample has to be determined because the LABROS SoilView-Analysis software needs the dry soil weight to calculate the volumetric water content based on the weight measurements.

1. Disconnect the sensor cable from the VARIOS.
2. Disconnect the HYPROP from the magneto cable.
3. Weigh an oven-safe frying pan and note the weight.
4. Open the clips of the HYPROP and remove the upper red retaining rings.

5. Carefully remove the sensor needle from the soil sample.
6. Hold the sensor needle over the drying pan and clean it with a brush so all particles land in the drying pan.
7. Remove the last red retaining ring.
8. Remove the soil sample with the sampling ring from the HYPROP sensor unit. Be careful not to break the tensiometer shafts.

   NOTE: If the soil sticks too tight to the sensor unit and the tensiometer shafts (this often happens when measuring clayey soils), put the whole system upside down in water. If necessary, leave it in water overnight. The sampling ring can then be easily removed.
9. Use a brush to clean the tensiometer shafts, the silicone disc, and the soil sampling ring.

   Be sure to collect all soil particles in the drying pan.
10. Place the drying pan with the soil sample in the drying oven and let it dry for 24 h at 105 °C.
11. Take the drying pan out of the oven and weigh it.
12. Subtract the tare weight and note dry soil weight in the LABROS SoilView-Analysis software.

For information about post-processing disassembling and cleaning the devices, please refer to HYPROP User Manual section 2.7 and VARIOS User Manual section 2.7.7.

4. EVALUATION WITH LABROS SOILVIEW-ANALYSIS

This section explains the special features of evaluating the combined HYPROP and VARIOS measurement. Both recorded data, HYPROP and VARIOS, need to be evaluated as usual. Please refer to the user manuals LABROS SoilView-Analysis for HYPROP and LABROS SoilView-Analysis for VARIOS for these evaluations. The file format of a combined HYPROP and VARIOS measurement is *.bhvdx.

4.1 INFORMATION REGISTER

The **Information** Register (the first of five tabs) is a window that contains ten blocks providing information about the selected project. Some data are editable by the Public User, and some are editable only by the Power User. For more information about the User options, please refer to section 2.2 in the user manual LABROS SoilView-Analysis for HYPROP. Other data cannot be altered by the user (these data are listed as the information specified by the LABROS SoilView data acquisition program and the respective firmware).

In a typical measurement evaluation, two input values must be specified by the user. This is at first the `Empty soil sampling ring weight` [g] in the group `HYPROP-VARIOS parameters.` Since the sampling ring weight differs from sample to sample, the weight of the ring must be specified for each measurement. Without this value, an evaluation cannot be performed. The second value is the weight of the silicone retaining rings used for fixing the VARIOS sensor needle to the soil sampling ring (Figure 26).

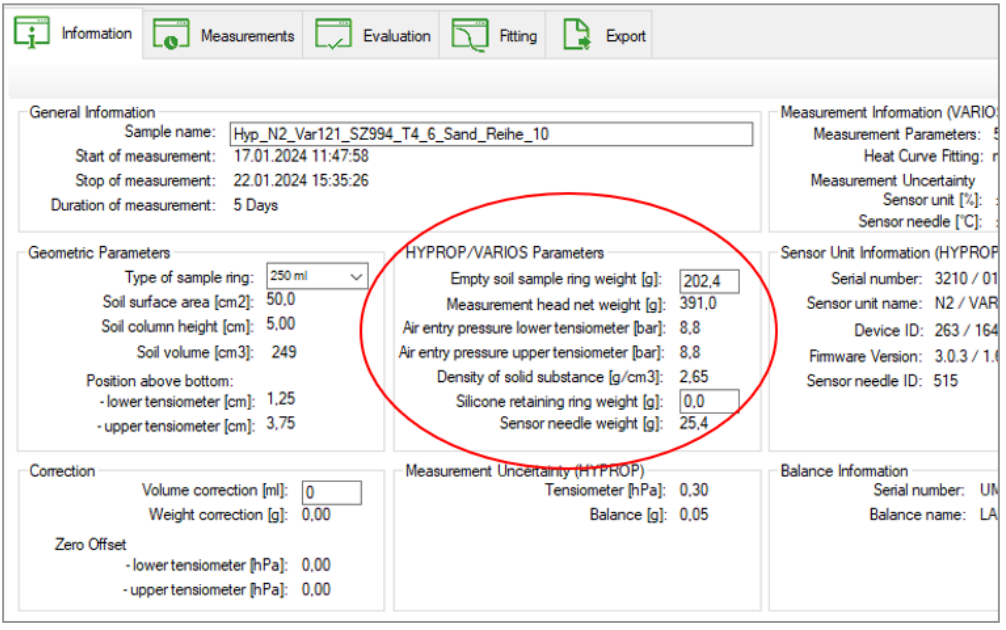


Figure 26 Information tab

For more power user evaluation options, please refer to section 4.1 in the LABROS SoilView-Analysis for HYPROP User Manual and section 4.1 in the LABROS SoilView-Analysis for VARIOS User Manual.

4.2 MEASUREMENT REGISTER

The **Measurement** register is for the visualization and editing of measured data. The measurements register shows the readings of the two tensiometers, the thermal conductivity readings, and the recorded weights. It is separated into three graphs and three tables (Figure 27).

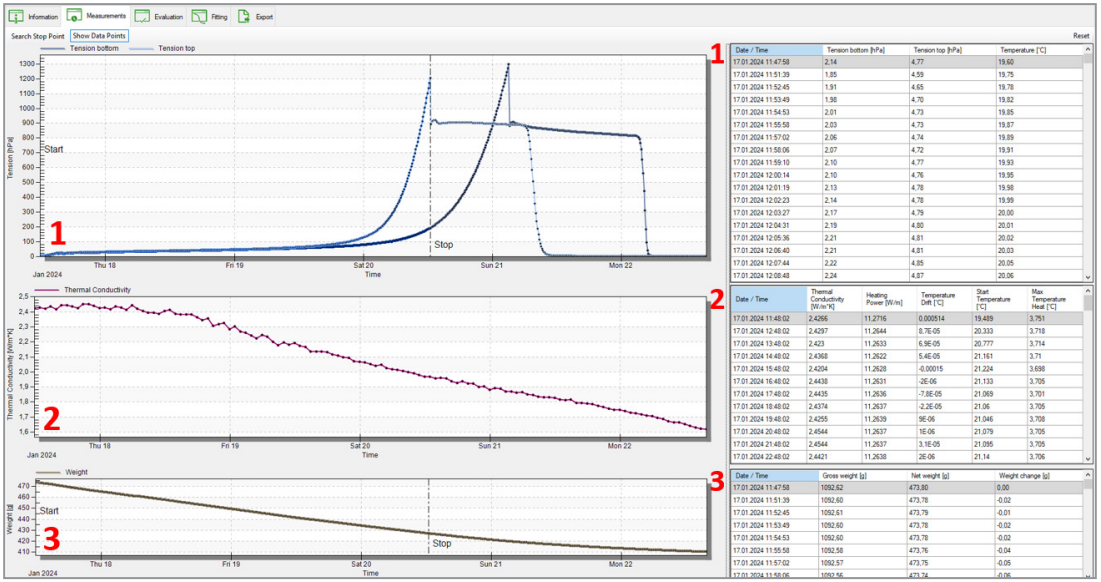


Figure 27 Measurement tab 3 parts

The first graph shows the recorded HYPROP pressure data over time. The single data points are listed on the right in the first table. For more information about evaluating and interpreting the potentiometric data, please refer to section 4.2.1 in the LABROS SoilView-Analysis for HYPROP User Manual.

The second graph shows the recorded VARIOS thermal conductivity data over time. The single data points are listed on the right in the second table. For more information about evaluating and interpreting the thermal conductivity data, please refer to section 4.3.1 in the LABROS SoilView-Analysis for VARIOS User Manual.

The third graph shows the recorded weight data, monitored by the LABROS balance. The single-weight data points are listed in the third table on the right. For interpretation of the weight data, please refer to section 4.3.4 LABROS SoilView-Analysis for VARIOS and section 4.2.5 LABROS SoilView-Analysis for HYPROP user manuals.

4.3 EVALUATION REGISTER

The following section describes how the **Evaluation** register calculates retention and conductivity data.

The Evaluation register shows five data groups in the upper part with specifications for the calculation of absolute water contents, calculated parameters, and four menus for adding additional data points.

Up to five graphs of the resulting retention, thermal, and hydraulic conductivity data are shown in the lower part. The first graph shows the volumetric water content versus pF(= decimal log of tension, expressed as pressure head in the unit of cm). The second graph shows the log of the hydraulic conductivity versus pF, and the third graph the log of hydraulic conductivity versus volumetric water content. The fourth graph shows the thermal conductivity versus volumetric water content, and the last one is thermal conductivity versus tension (Figure 28). The individual graphs can be switched on or off by pressing the respective buttons located immediately above the graphs, to the left. Switching a graph on or off will resize the remaining graphs.

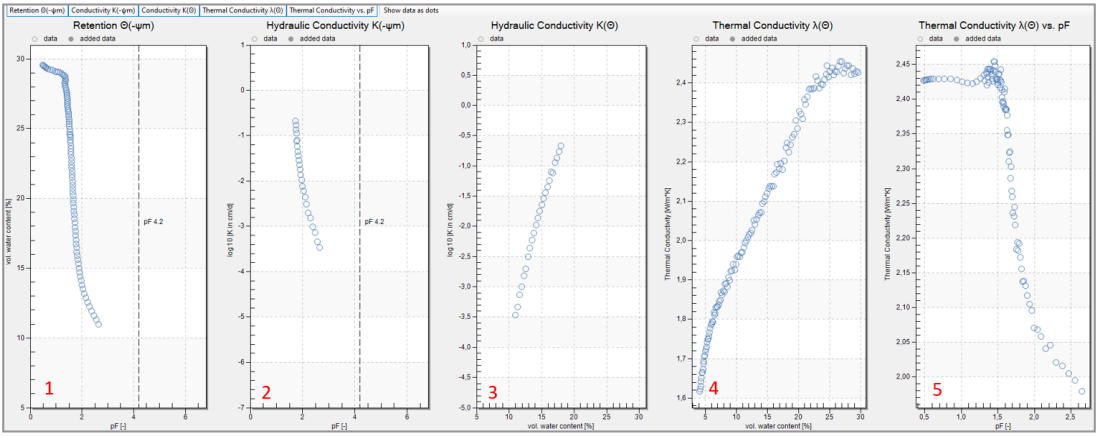


Figure 28 Evaluation curves

The absolute water content must be evaluated using one of the three options under `Calculation of water contents` (Figure 29). The first option listed is the recommended choice as it leads to a 100 % correct calculation of the absolute water content. The next two options listed are just estimations. For more information about the three options, please refer to the LABROS SoilView-Analysis for HYPROP User Manual section 4.3.2.

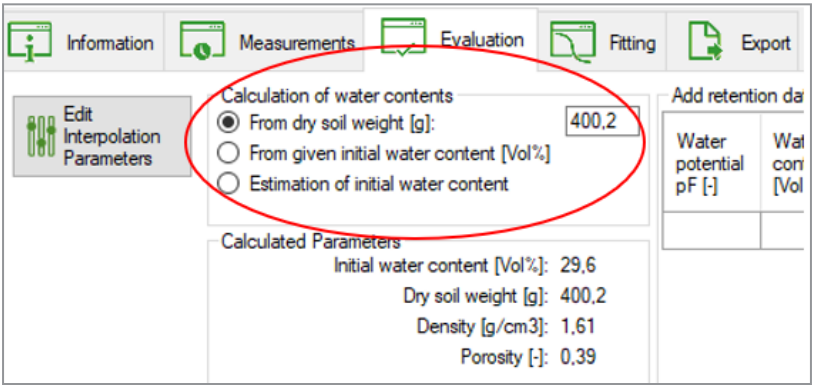


Figure 29 Calculation of water contents

4.4 FITTING REGISTER

This section describes how the **Fitting** register tab fits thermal conductivity and retention functions to the data.

For HYPROP data fitting, sixteen widely-used retention models are available, encompassing the expressions of Brooks and Corey, Fredlund-Xing, Kosugi, and van Genuchten with and without parameter constraint for the parameter m. With the exception of the Brooks-Corey model, all functions are available as PDI-variant in uni- and bimodal form. The PDI-variant ensures that the water content matches zero at oven dryness, and it considers the effect of water in capillaries, in films, and in corners of pores in both the retention function and conductivity function. For more detailed information about the fitting models and all involved parameters, please refer to Appendix C of the LABROS SoilView-Analysis for HYPROP User Manual.

For VARIOS data fitting, six widely-used conductivity models are available. LABROS SoilView-Analysis software provides a high-class algorithm to fit a variety of functional relationships of the (θ) curve to the data (C is the sum of the head capacities of the mineral, the organic, and the liquid phases). For detailed information about the different fitting models and all the parameters involved, please refer to section 4.5.1 of the LABROS SoilView-Analysis for VARIOS User Manual.

To fit the data, the desired model has to be selected in the respective tab of the soil hydraulic model selection table (Figure 30). Switch between `HYPROP` and `VARIOS` to select the respective model.

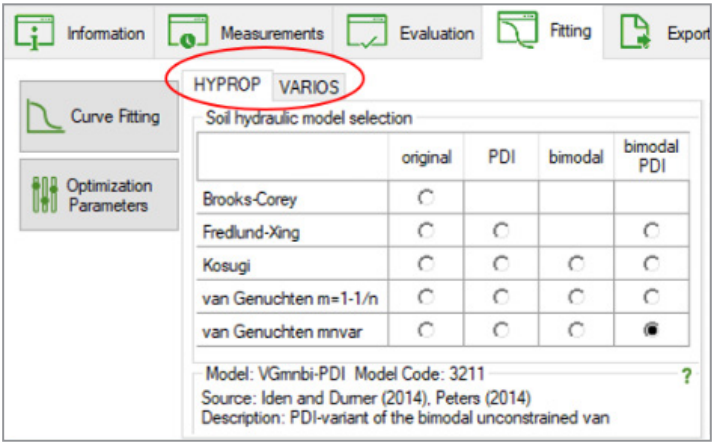


Figure 30 Selecting a model

Left-click on the Curve Fitting button to fit the selected function to the data. A window will pop up that indicates that the fitting routine is running. This process will last only a few seconds and cannot be stopped or otherwise interrupted.

NOTE: In some cases, the fitting process will work continuously and not lead to completion. In these cases, the user can cancel the process in the Windows Task Manager.

Using a global optimization scheme, the fitting algorithm minimizes the sum of squares deviations between data points and fitted functions.

4.5 EXPORT REGISTER

The Export Register tab enables the export of all graphs, raw data, calculated data, fitted functions, and other parameters of interest. User specifications for data format, file name convention, and directory will be kept as default as long as the user remains in the session.

LABROS SoilView-Analysis supports the Microsoft Excel® output file format (*.xlsx). The Excel file will contain all relevant data in different worksheets:

- Configuration and information
- Measured data
- Evaluation of measured data
- Fitted data
- Parameters of fitted models
- Correlation matrix of fitted data
- Statistical analysis
- Measured raw data (if specified)

By selecting the `Export` button, all these data will be exported to an Excel file. For more information about Export options, please refer to section 4.6 of the LABROS SoilView-Analysis for VARIOS and section 4.5 of the LABROS SoilView-Analysis for HYPROP user manuals.

4.6 CUSTOMER SUPPORT

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Customer service representatives are available for questions, problems, or feedback Monday through Friday, 7:00 am to 5:00 pm Pacific time.

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If contacting METER by email, please include the following information:

Name	Email address
Address	Instrument serial number
Phone	Description of the problem

NOTE: For products purchased through a distributor, please contact the distributor directly for assistance.

4.7 TERMS AND CONDITIONS

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