

INSTRUCTIONS FOR THE GHG MEASURERS

**Cover note:**

These instructions are applicable for manual greenhouse gas measurements in the field (or in the laboratory, where applicable) when using a portable gas analyser LI-COR LI-7810 (CH₄, CO₂, H₂O) or LI-COR LI-7820 (N₂O, H₂O) for the measurements.

Instructions updated: 17.3.2021

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Photos: Petri Salovaara, Päivi Mäkiranta

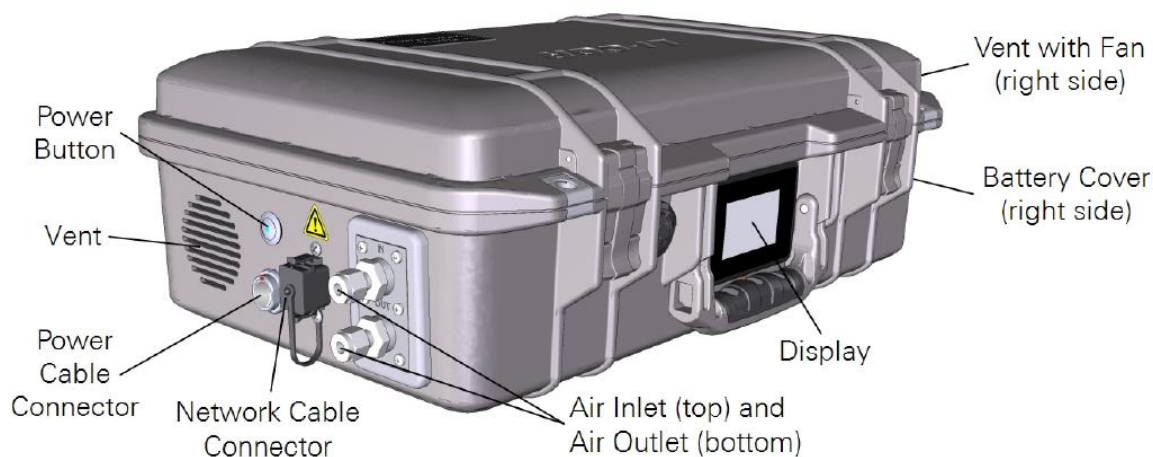
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1. General description of the measuring device

LI-COR LI-7810 ("Ten") is a gas analyser for field measurements of methane (CH_4) and carbon dioxide (CO_2) and LI-COR LI-7820 ("Nitro") for nitrous oxide (N_2O). The in-built pump of the device draws air into the laser analyser that measures the contents of gases (one measurement per second). After this the pump returns the air back outside the device.

The power button, cable connectors, display and battery cover location are shown in the illustration below.



2. Equipment required for the measurements

- Analyser and batteries (2 pcs)
- Stand-by batteries (2 pcs, recommended)
- Stopwatch or wristwatch with digital display
- Measuring chamber (provided with fan and inside air thermometer)
- A battery for the measuring chamber fan (+ stand-by battery, recommended)
- Tubes connecting the analyser and the measuring chamber
- Soil thermometer
- Ground water level measurement equipment (needed e.g. on peatlands)
- A tablet, (field)computer or measurement forms on paper with a clipboard
- Ethernet cable (RJ-45)
- Duct tape

3. Adjusting the chamber fan

Before starting the measurement, the chamber fan must be adjusted to suitable outlet velocity. The velocity is correct when the fan is on the lowest possible speed but keeps running smoothly. Without the fan the gases gather in layers inside the chamber and the measuring results become distorted. Too powerful ventilation, on the other hand, blows gases from the porous soil and makes the flow seem bigger than it actually is.

4. Charging the batteries of the gas analyser

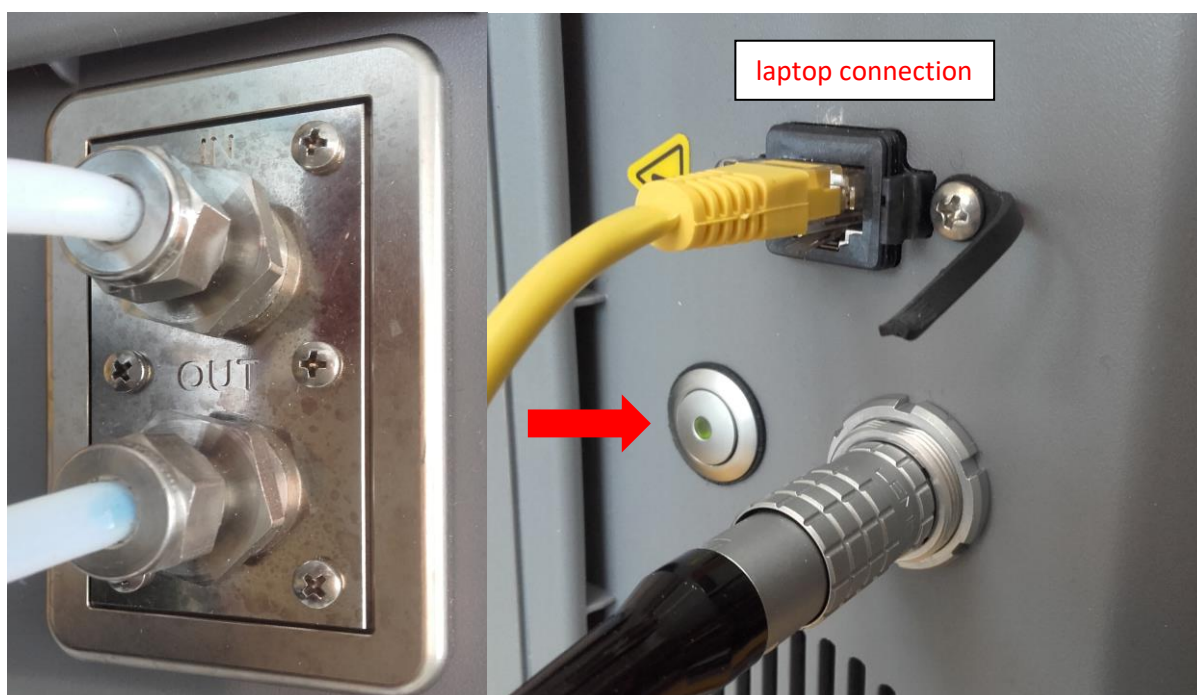
The Licor batteries (2 pcs) are situated on one side of the equipment behind a black lid. The batteries of the equipment are adequate for ca. five hours' measurements in the field (warming up + measurements). The batteries are charged either in a separate docking station or inside the equipment. Note that when attaching the docking station, the red dots need to be aligned and the checkered sheath is pulled back when attaching. The charge level of a single battery can be checked at the end of the battery (the charge of the battery in the photo below on the right is ca. 80%).



5. Using the gas analyser

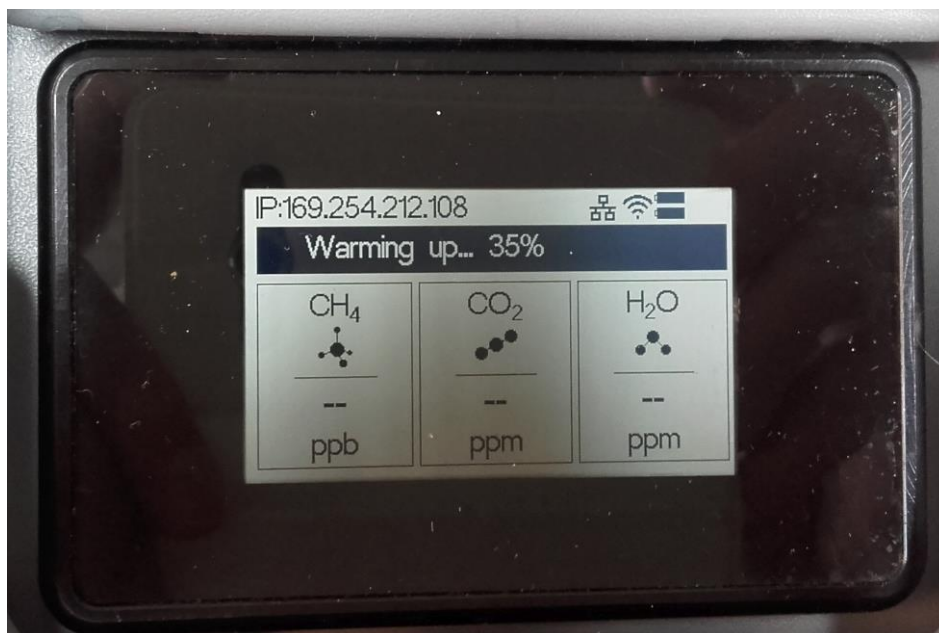
5.1 Starting

Attach the tubes coming from the chamber into the Licor. The tube with the filter is always attached with swageloc into IN inlet (the upper one in the photo). The other tube is attached into the OUT outlet (the lower one in the photo). In the chamber it does not matter to which hole the tubes are attached (this has to be confirmed still). Switch the power on by pressing the button on one side of the device (red arrow in the photo). In a short while the device starts humming and text will appear on the display.



5.2 Attaching the device into a laptop or a tablet

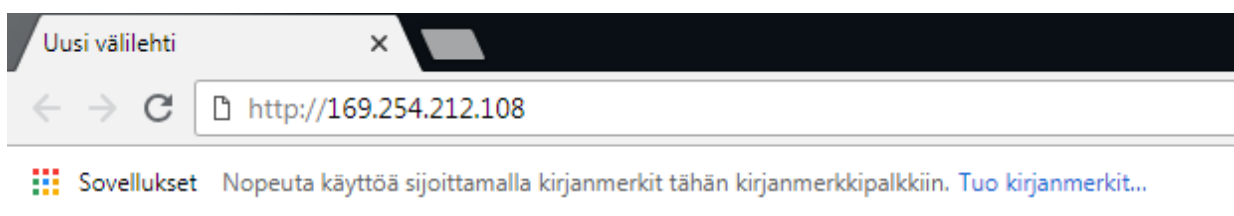
Before you can measure anything with the Licor, the device must warm up to a certain temperature and calibrate itself. You can attach the device into a laptop or tablet and follow up the warming up on the display. The warming up takes about 30 minutes depending on the outside temperature. On the Licor display you can see the warming up in per cents (35 % in the photo below).



5.2.1 Attaching with Ethernet cable

Attach an Ethernet cable between the Licor and the laptop. When the power is on in the Licor, an IP address is blinking on its display. In the photo above the IP address is 169.254.212.108. Open Google Chrome with your laptop or tablet and write in the address field:

1. The IP address blinking on the Licor display: <http://169.254.212.108> (note that the IP address is different for each device)



2. The serial number blinking on the Licor display: <http://tg10-nnnnn.local> (note that the IP address is different for each device)

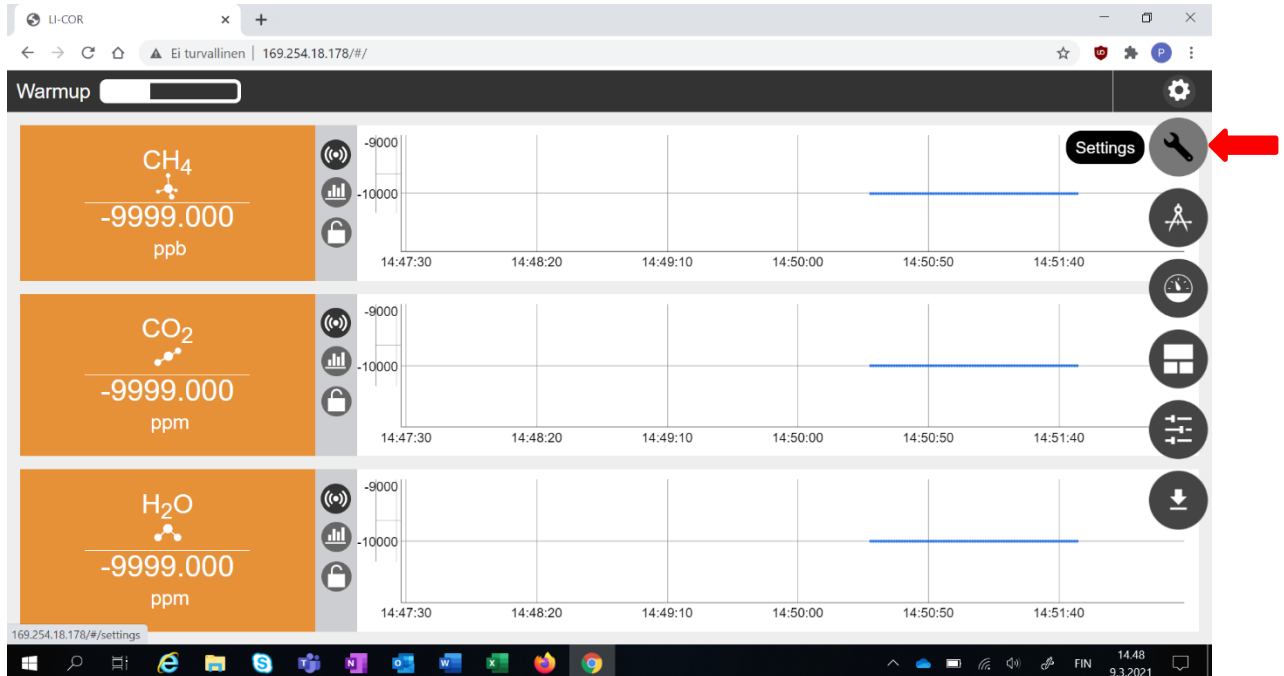
5.2.2 Connecting with Wi-Fi

Connect the laptop or tablet to the wireless net "TG10-nnnnn". The password is "licorenv". Open Google Chrome with your laptop or tablet and write in its address field:

1. The IP address blinking on the Licor display: <http://169.254.212.108> (note that the IP address is different for each device)
2. Fixed IP address: <http://192.168.10.1>

5.3 Cross-checking the time on the clock/watch

Before starting the measurements, it is crucial to check that your watch and the time on Licor are synchronised. Adequate accuracy is about +2 seconds. Choose "Settings" in the "cogwheel menu" on the right upper hand corner.



Clicking it opens the screen below (choose tab "Time"):

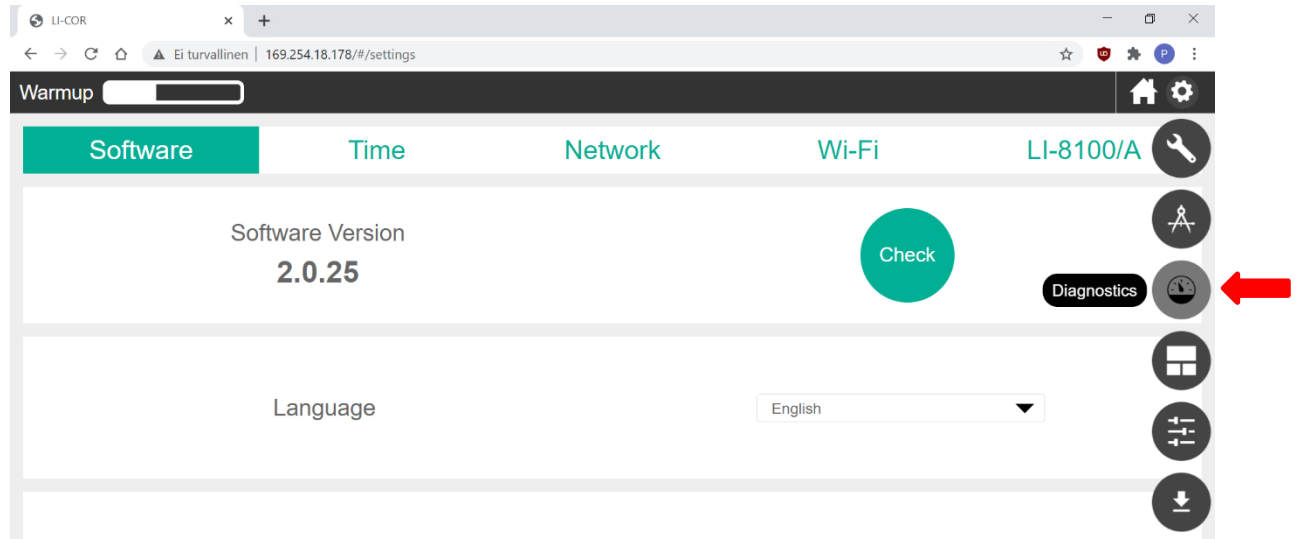
The screenshot displays the 'Time' settings page within the LI-COR web interface. The page has tabs for 'Software', 'Time', 'Network', 'Wi-Fi', and 'LI-8100/A', with 'Time' currently selected. Under the 'Instrument Time' section, the 'Auto Sync' checkbox is checked and circled in red. Below it, 'NTP' is selected as the time source, with 'auto' in the server field. The 'Date' is set to 03/09/21, and the 'Time' is set to 14:53:14, both of which are also circled in red. An 'Update' button is located at the bottom center of the settings area.

Remove the tick from "Auto Sync" box and click "Time". Write there the correct hours and minutes. Check also that the "Date" is correct (in the form month/day/year). Five seconds before your own

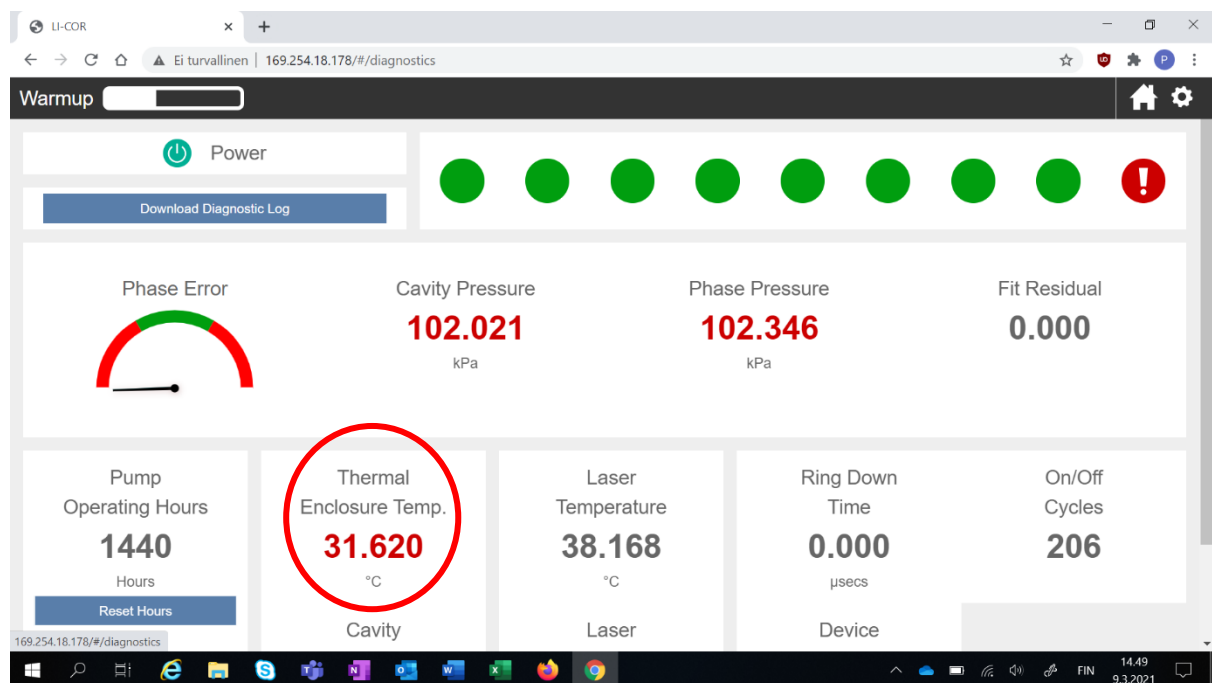
watch reaches the same time, click the “Update” button. Now the time is synchronized between your watch and Licor.

5.4 Proceeding of the warmup and diagnostics

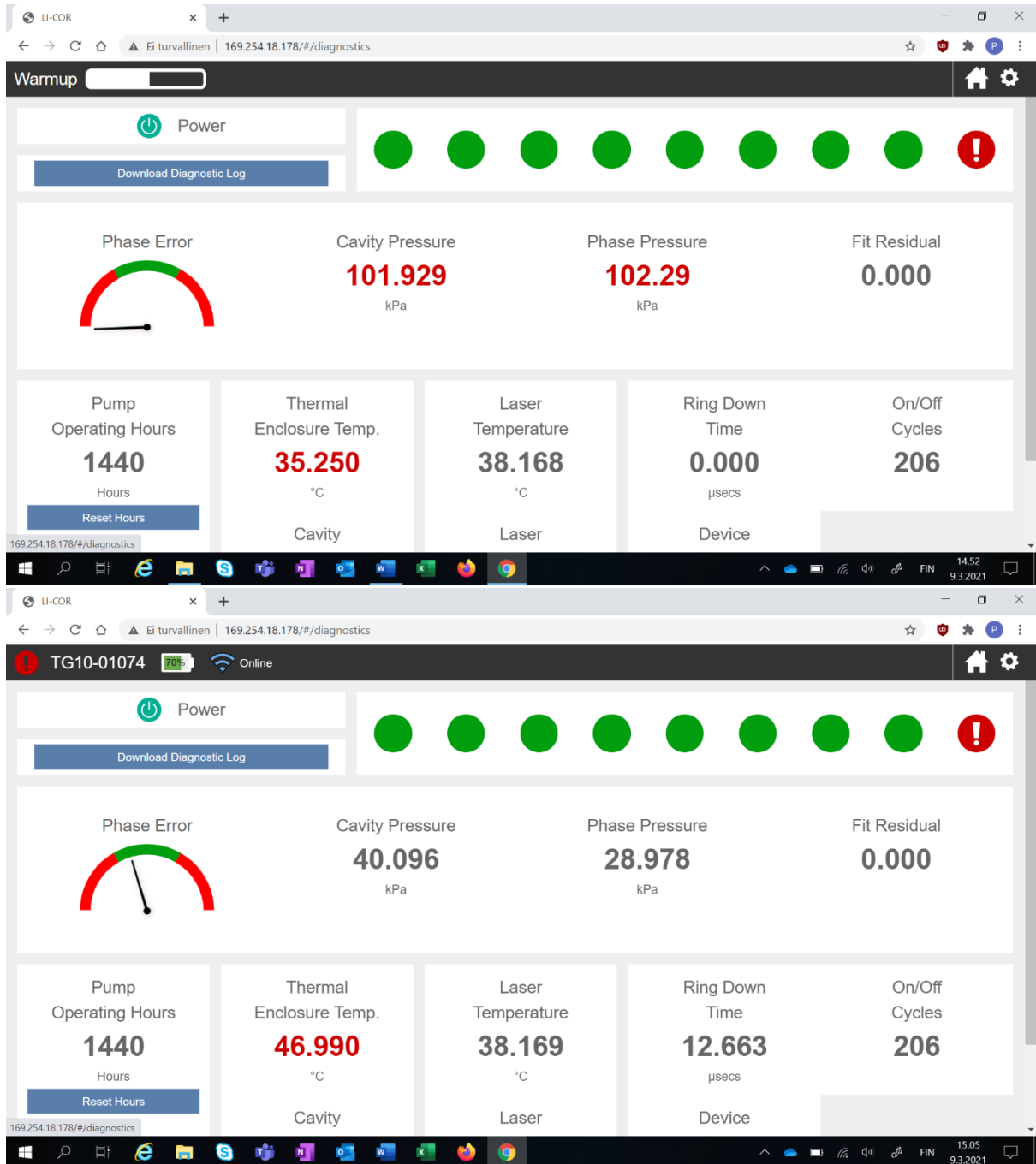
You get access to the diagnostics of the device by choosing “Diagnostics” in the in the “cogwheel menu” in the upper right corner.

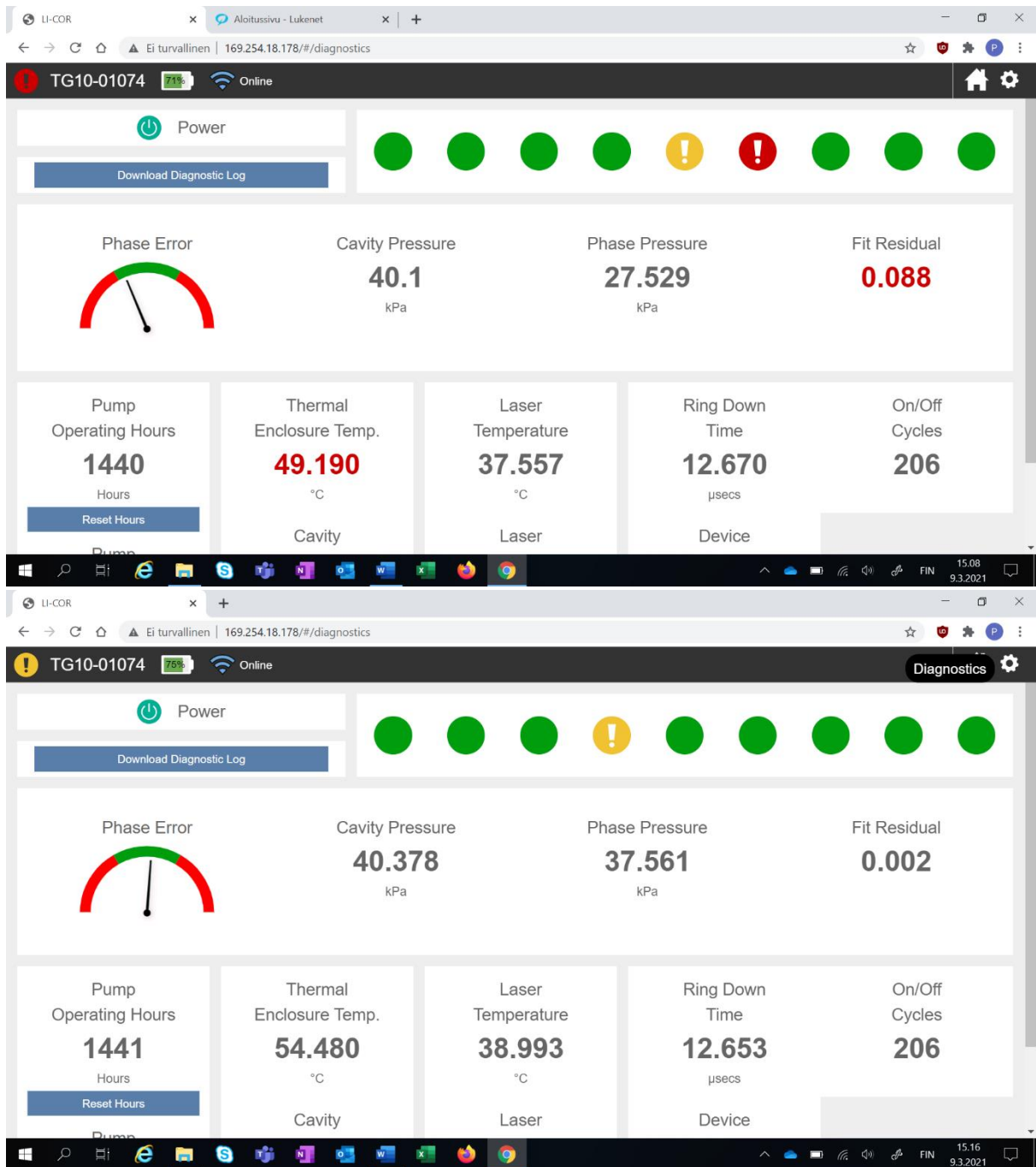


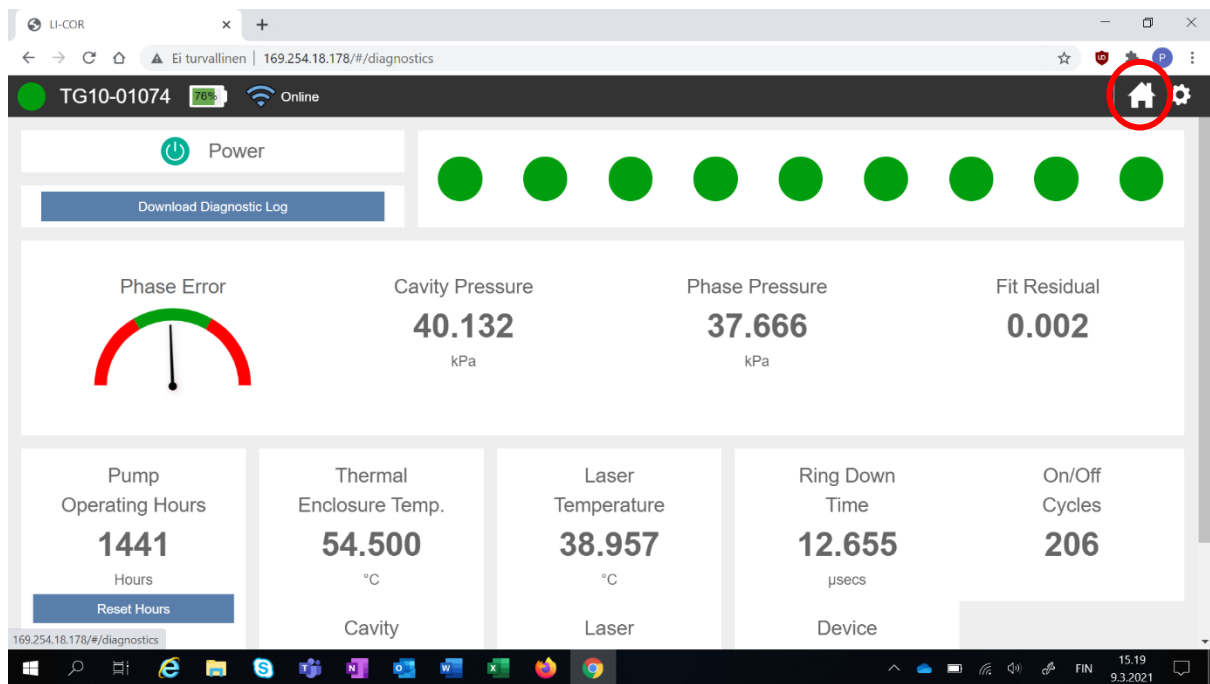
Clicking it opens the screen below:



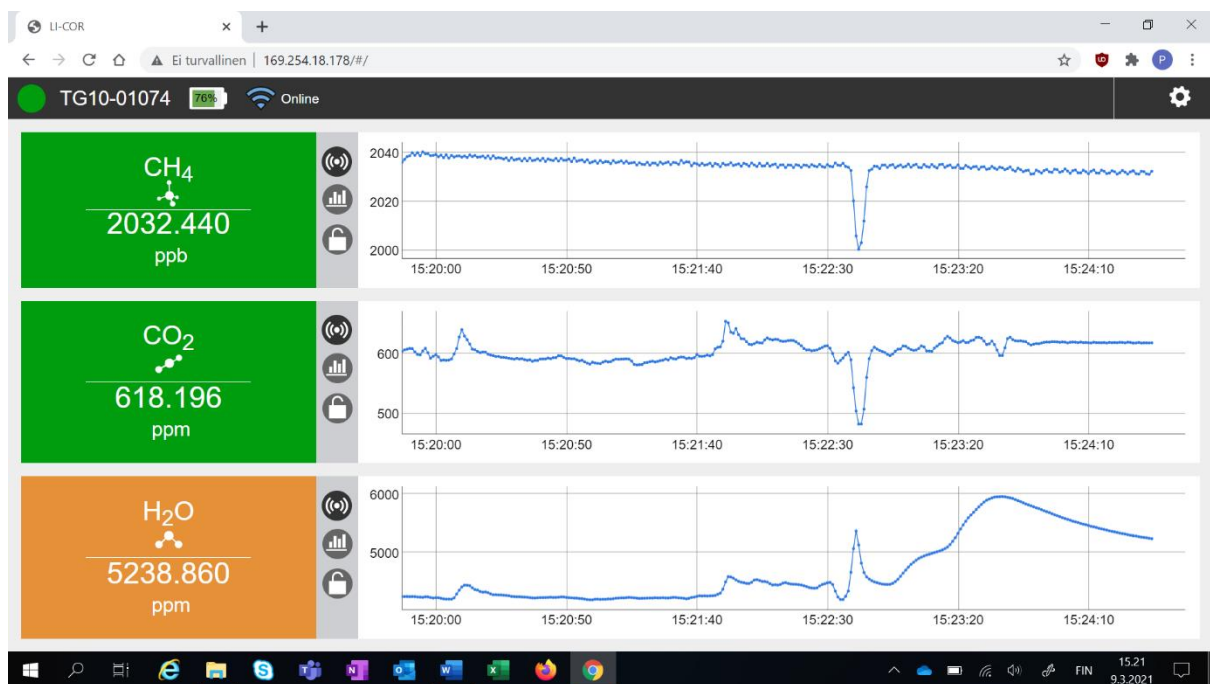
The equipment has not yet warmed up sufficiently or performed calibration, because all the balls should be green and the reading for “Thermal Enclosure Temp.” should be 54.500 (in the figure it is 31.620). The symbol for the charging percent of the batteries will appear on the upper left corner beside the Warmup bar as the warmup proceeds. The next phases are illustrated below:







When all the balls are green and "Thermal Enclosure Temp." reading is 54.500, the analyser has warmed up and calibrated itself, i.e. is ready to make reliable measurements. By clicking the cottage icon in the upper right corner you get back to the main display showing the concentrations of the gases.



6. Filling in and naming the measurement forms

NOTE! This is based on the one example data sheet, has to be modified according to data sheet in use.

During the measurements data is filled in on the "Measurements" tab.

- The date and place of the measurement and the identifier of the measurement point (number or number-letter combination) are entered in the form.
- From the Start time and the End time in the form we can see under which three-minute period the data is usable.
- The temperature within the chamber is entered in the form from the thermometer on top of the chamber at the start and at the end of the measurement.
- During the measurement a soil thermometer is pressed into the soil beside the measuring point into 5 cm depth and the reading is recorded. Then the thermometer is pressed into 30 cm depth and the reading is recorded.
- Measuring the water level:
 - **IF** there is a manual water well at the measurement point, the water level is measured during the chamber measurement or after it and the reading is recorded. Also, the length of the above-ground part of the well is recorded.
 - **IF** the data from the same water well is used for several gas points, the soil level data is recorded on a separate form.
- In case something divergent is observed, or e.g. the groundwater well is empty, this will be recorded in the "Notice" column of the form.

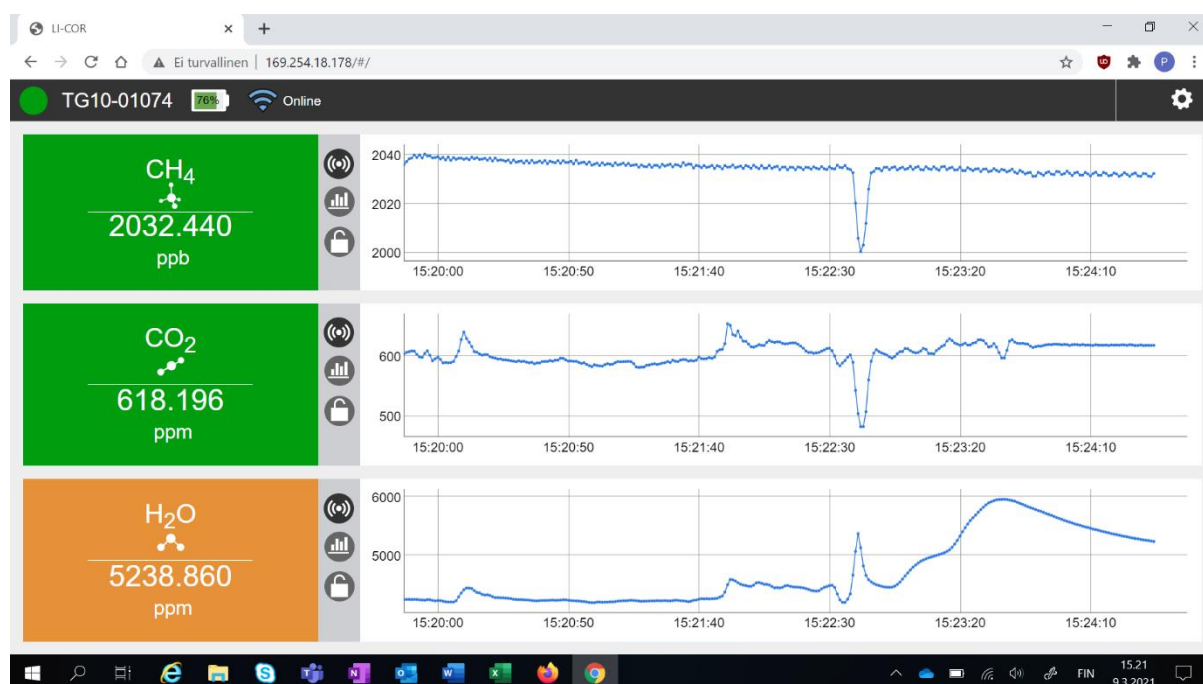
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
	Date	Site	Plot	Start time	End time	Chamber T_start, C	Chamber T_end, C	T at 5, C	T at 30, C	WT_measured, cm	WT_well_corr, cm	WT_real, cm	Canopy cover	Notice!
1	1.1.1900	viikki	1	12:00:00	13:00:00	12,3	23,4	1,2	2,3	20	9	11	0	
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7. Measuring instructions

- 7.1 Carry out the preparations: start the Licor and wait for it to become ready for use (more about the starting and warming-up of the Licor in chapter 5). Attach the chamber to Licor. Start the fan of the chamber and make sure that its rotation speed is suitable (see chapter 3). Attach the computer/tablet to Licor and synchronise the time with your watch.
- 7.2 When arriving to the measuring point, you can start with measuring the soil temperature. Measurements are made from specified depths (upland soils usually from 10cm and 30cm depth, in drained peatlands usually 5 and 30 cm, in virgin mires 5 and 15 cm). Start the thermometer, press its sensor into the soil at the specified depth in the vicinity of the measuring point and wait for the temperature to stabilize.

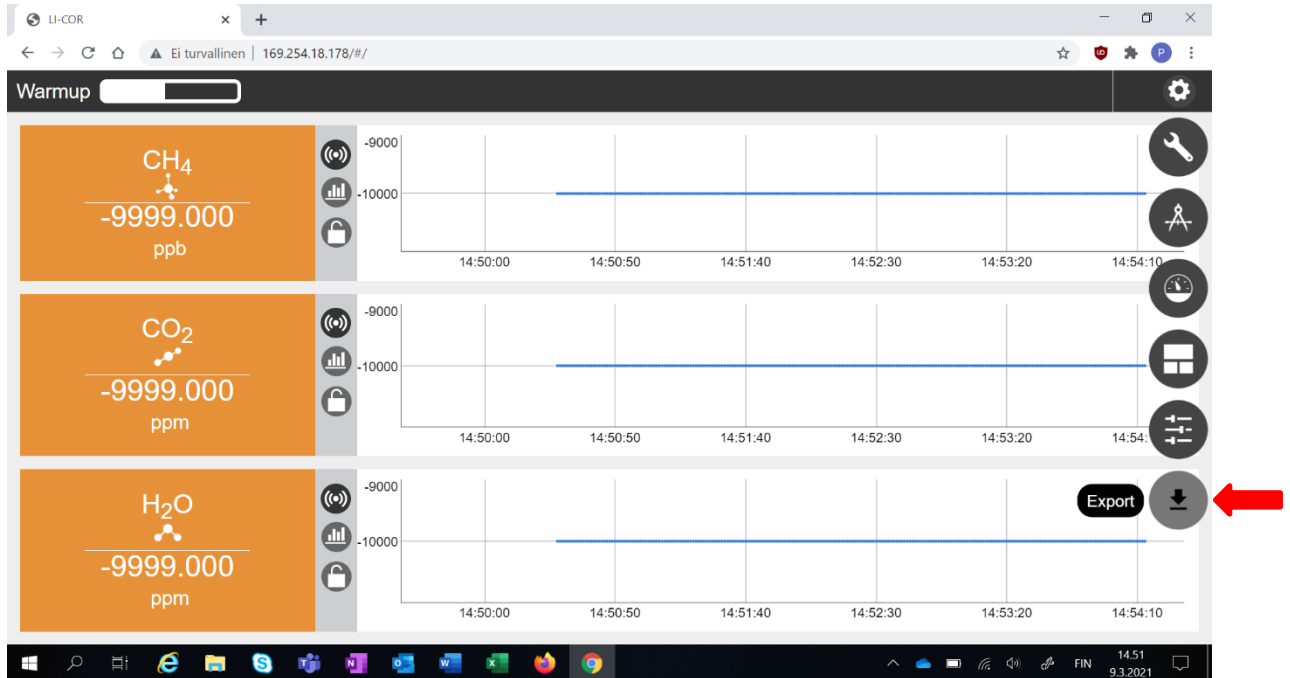
- 7.3 Ventilate the chamber by holding it above ground level. Wait until the concentrations of the gases are stabilised (concentrations in the background air: CO₂ usually ca. 400-450 ppm, CH₄ ca. 1900-2000 ppb). You can see the concentrations of the background air e.g. on the Licor display or the laptop (if connected).
- 7.4 Place the chamber over the measuring point about 20 seconds before starting the measurement and check that it is tight (there are no gaps between the ground and the edge of the chamber). Close the pressure balancing valve. It is recommended to start the measurement at even minute (e.g. 14:22:00) or halfway through the minute (14:22:30). Record the starting time.
- 7.5 Record the inside temperature of the chamber at the start of the measurement. Record also the soil temperature. If necessary, press the sensor deeper and record the temperature again after a short while.
- 7.6 If the measuring point is not measured from duckboards (wooden bridge to walk), stay as still as possible during the measurement. Especially avoid jumping! During the measurement you can also measure the water level if possible.
- 7.7 You can follow the evenness of the gas fluxes either on the Licor display or the tablet/computer. The aim is an even rise of CO₂.
- 7.8 When the measuring time is over, continue waiting for about 20 seconds. Record the end time of the measurement and the end temperature. Open the pressure balancing valve and lift the chamber away from the measuring point.
- 7.9 When all the localities are measured, the Licor is switched off by pressing the power button three times within two seconds. After a short wait the device switches off.

From the main display you can follow the concentrations of the measured gases and the progress of concentration curves during the measurement:



8. Saving the data and naming the file

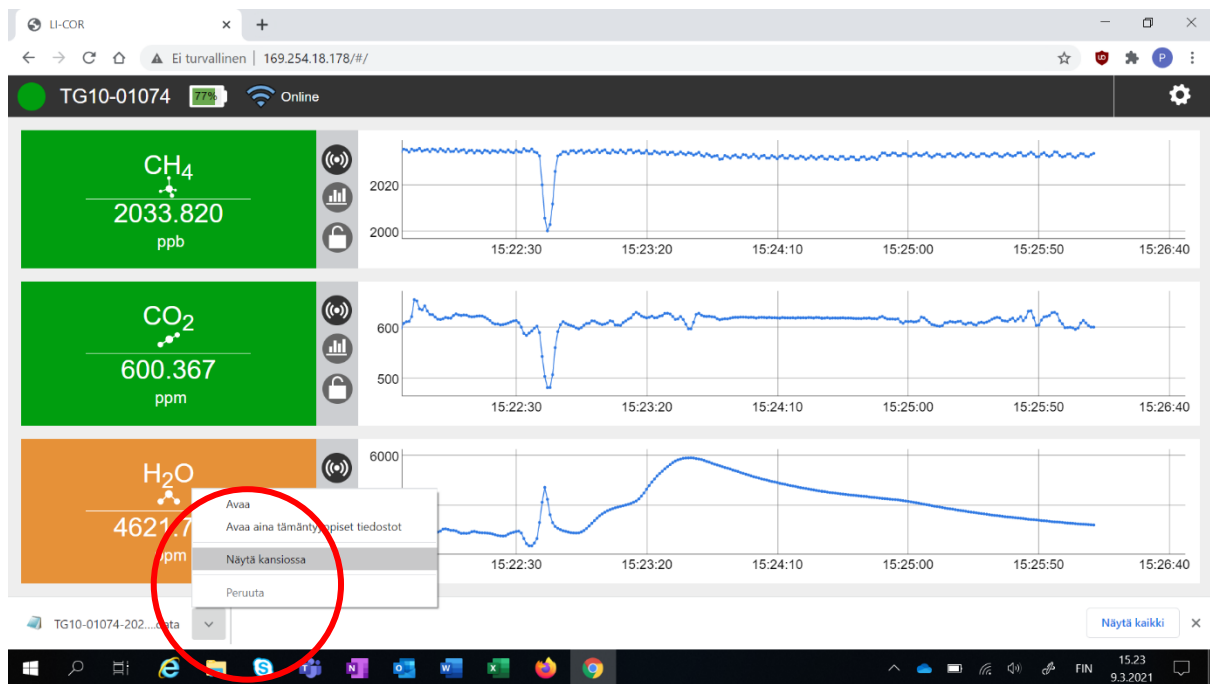
The measurement data is transferred and saved to the computer at the end of the day. Licor is switched on and attached to the computer either with a cable or using Wi-Fi. When attached (see chapter 5.2), click “Export” in the cogwheel menu.



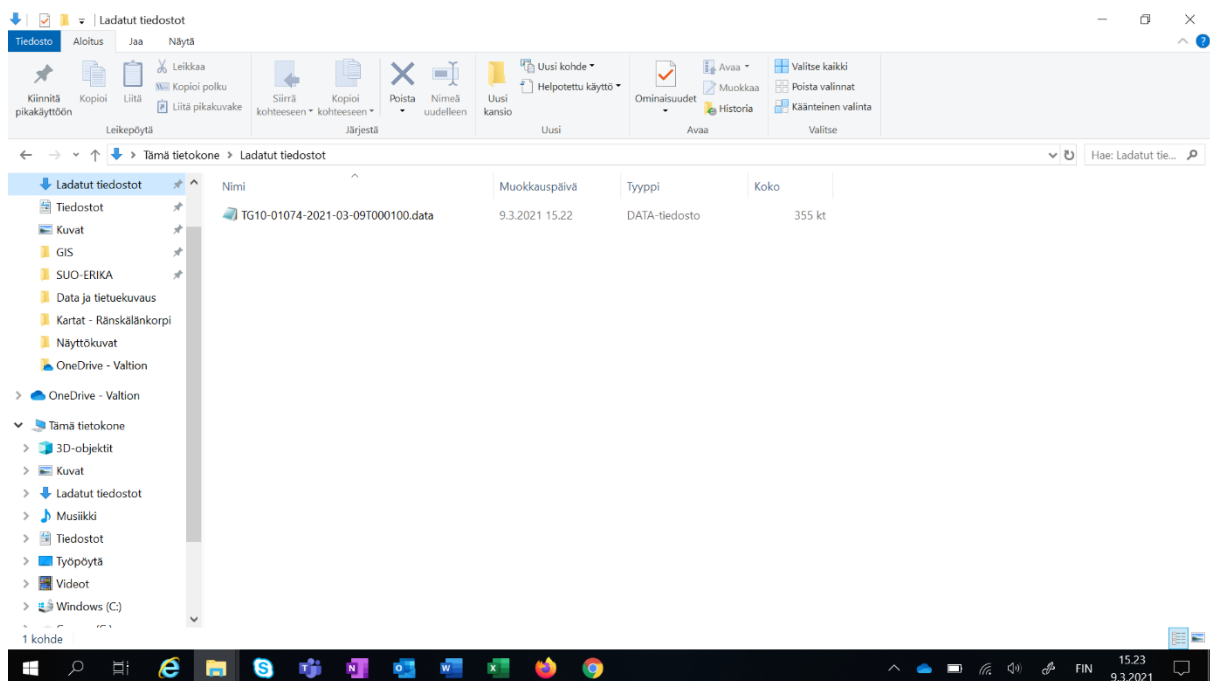
Choose the start and end time of the measuring data to be transferred. Save each measurement day in its own file. It is recommended to put some extra time to both start and finish, i.e. in "Time" you can put e.g. 06:00 and 18:00 if the actual measuring have been done 9-16.

The left screenshot shows the 'Export Data' dialog box with the 'Start Date & Time' field set to 2021-03-07 06:00 and the 'End Date & Time' field set to 2021-03-07 18:00. The right screenshot shows the 'Export' button highlighted.

When clicking “Export” the data will be saved in the computer and with Google Chrome it appears in the bottom bar. By clicking the arrow and choosing “Näytä kansiossa” from the pop-up menu you get access to the folder where the data was saved.



In this case the data has been transferred in the folder "Laditut tiedostot" of the computer and been named "TG10-01074-2021-03-09T000100.data".



You should rename the file so that the name indicates where, when and with which device the measurements have been performed: **2020-06-22_licor_lettosuo_tg10-nnnnn.data**

9. Sources of error and suggested corrections:

The concentration of carbon dioxide in the dark chamber does not elevate

- It is likely that the chamber leaks, i.e. either the edge is not tightly against the ground or there is a hole in the chamber.
- Check if the pressure balancing valve is open.
- Restart the measurement from the beginning. If the situation is not corrected, try measuring that point again later.
- If the situation occurs also in other measuring points, it is possible that the analyser is defective. Check the diagnostics and restart the device.
- If the situation does not get fixed, contact maintenance personnel.

The rise of the concentration is not linear

- It is possible that the fan has switched off or is on too high speed.
- Check that the fan is in order and on correct velocity.
- Restart the measurement from the beginning. The situation may or may not improve.

The pump does not start

- Restart the device. If the pump still does not start, contact maintenance personnel.

The device has calibrated itself for over 45 minutes

- If outdoor temperature is low, 45 minutes warming up time is not uncommonly long. Wait some more time.
- If the device still has not switched over to normal, restart the device.
- If the outdoor temperature is high, restart the device.
- If the situation does not get fixed, contact maintenance personnel.