BioLogic

Getting Started with EC-Lab®:

Constant Current Constant Voltage

Getting Started EC-Lab: CCCV

V1

March 2024

Overview and quick access

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    - Step 8: Analyse the data with Process Data
- Find out more
  - For supplementary information
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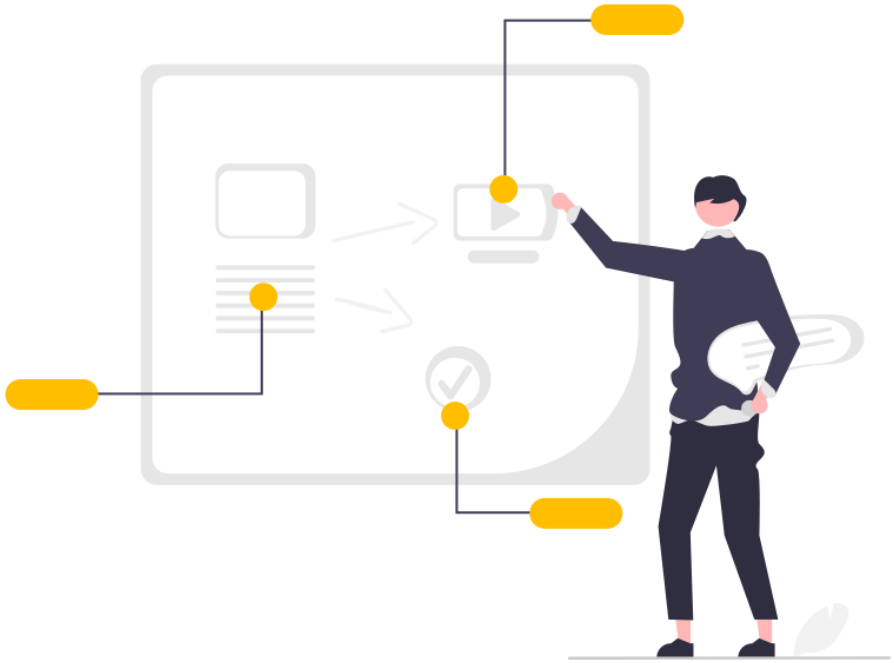
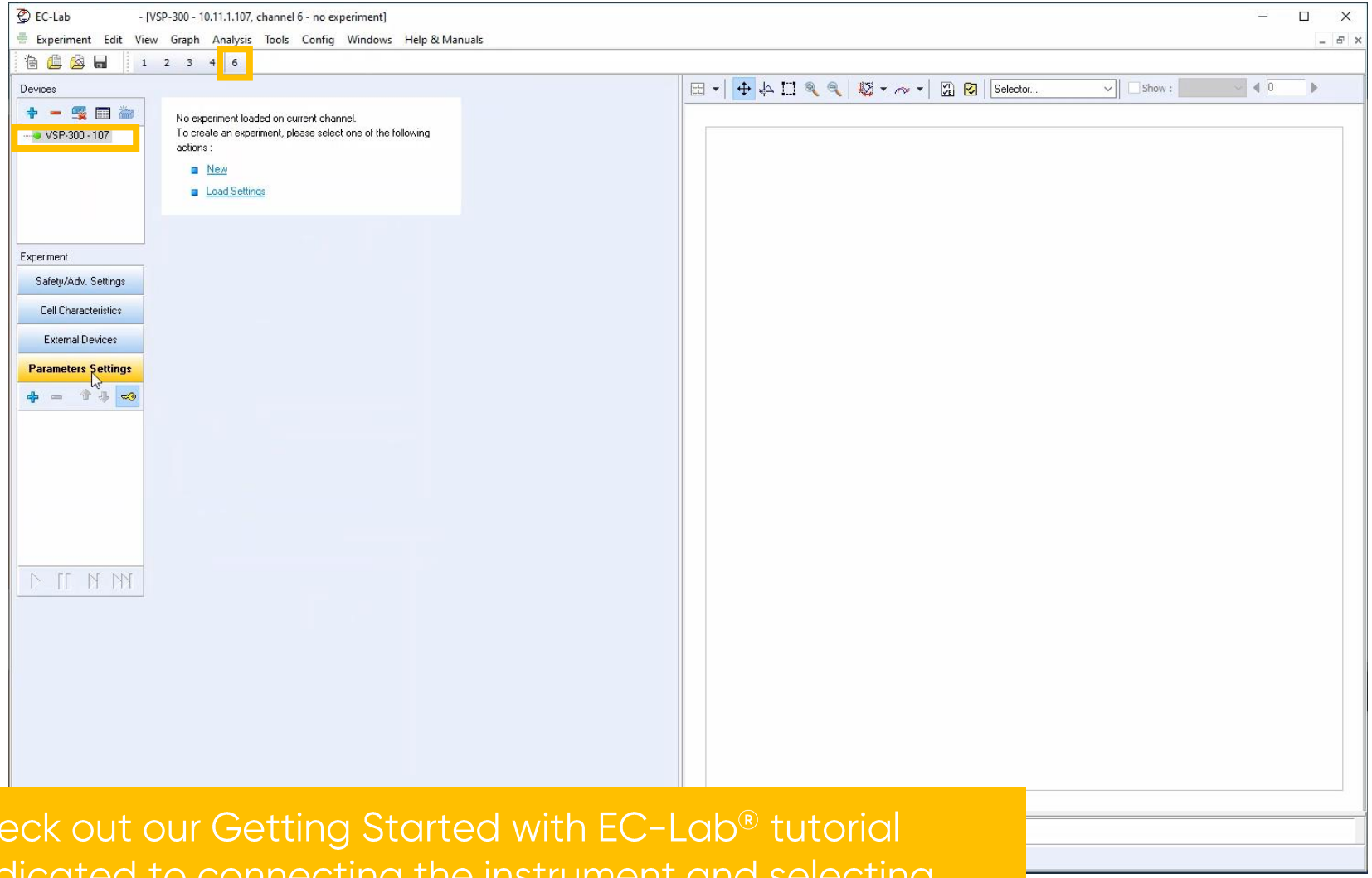
Note: Go back to this slide by clicking on the logo on the top left corner



Procedure

Step 0: Connect instrument and select channel

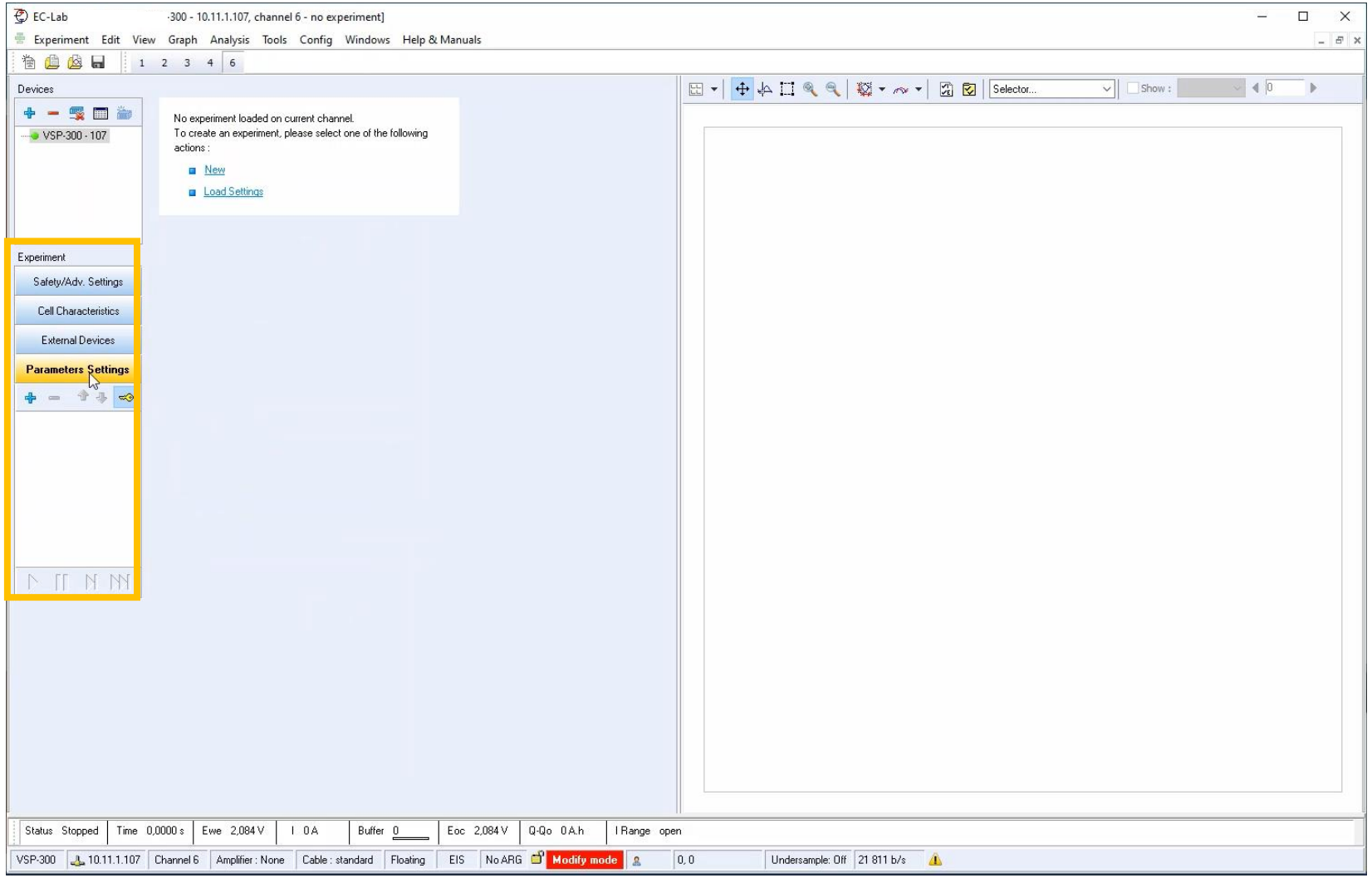
- Connect instrument and select channel



Check out our Getting Started with EC-Lab® tutorial dedicated to connecting the instrument and selecting channels.

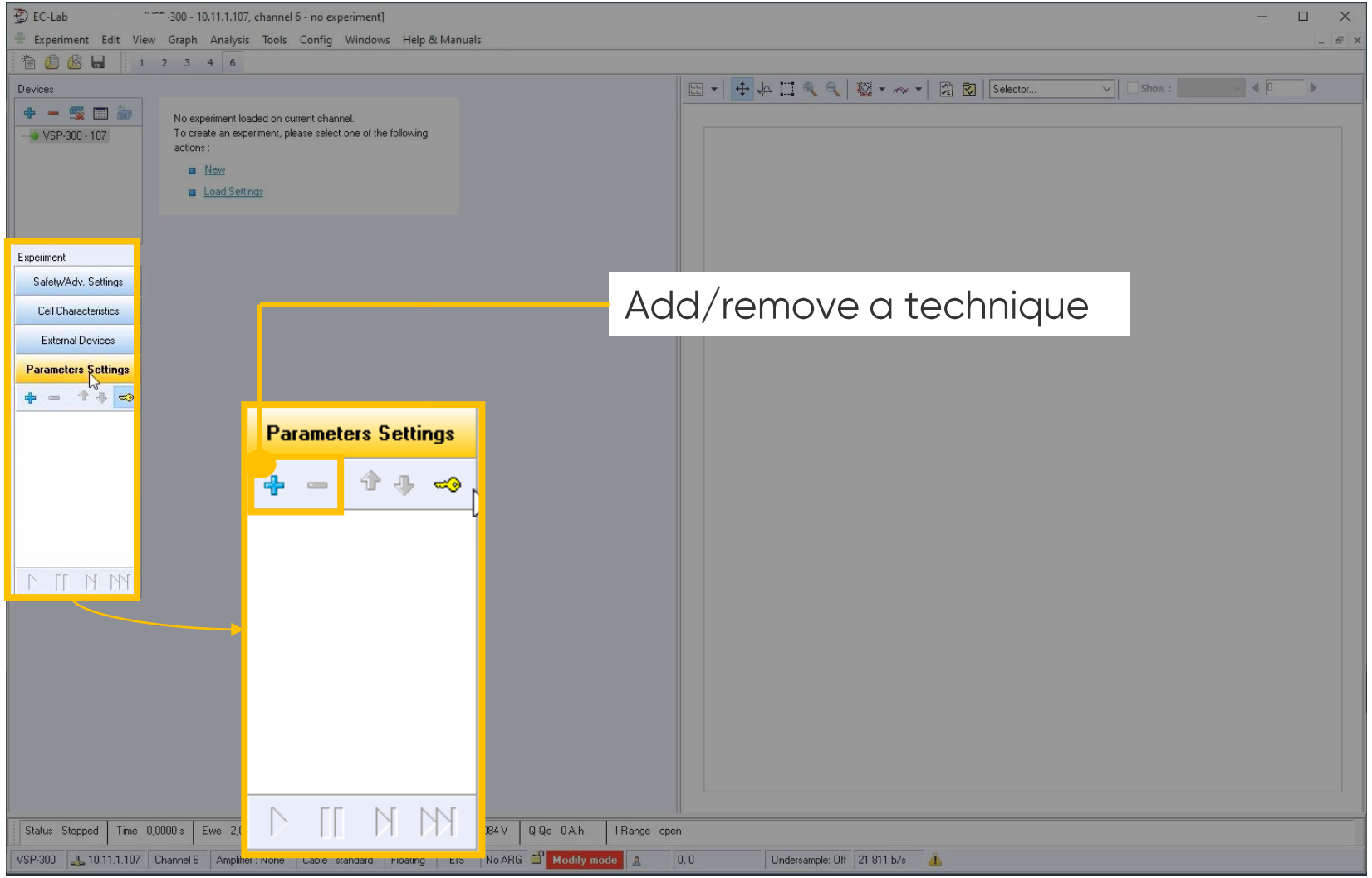
Step 0: Connect instrument and select channel

- When the instrument and channel are selected, the user can set the experiment

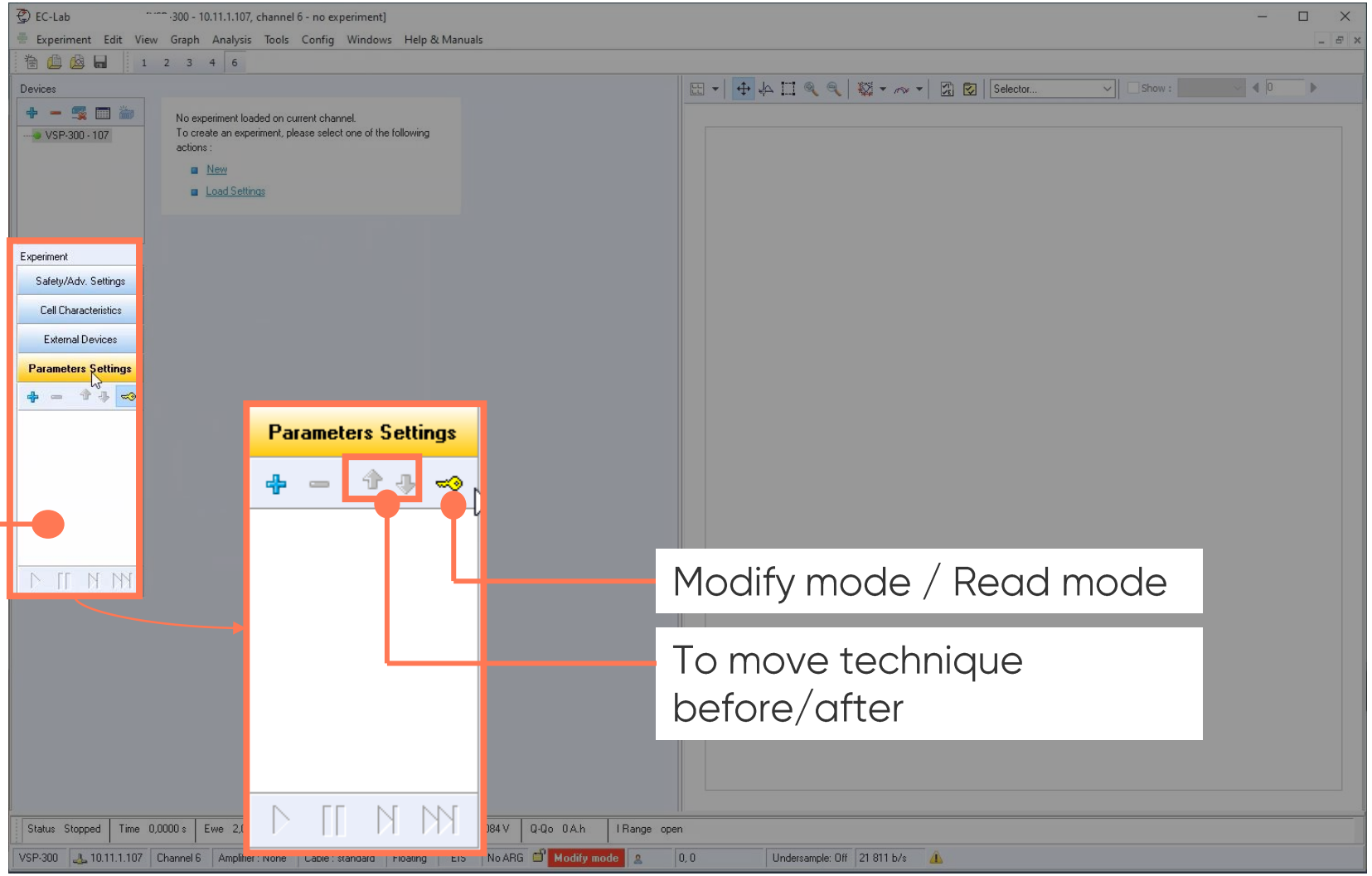


Step 1: Add CCCV technique

- Click on + to add a technique in the list

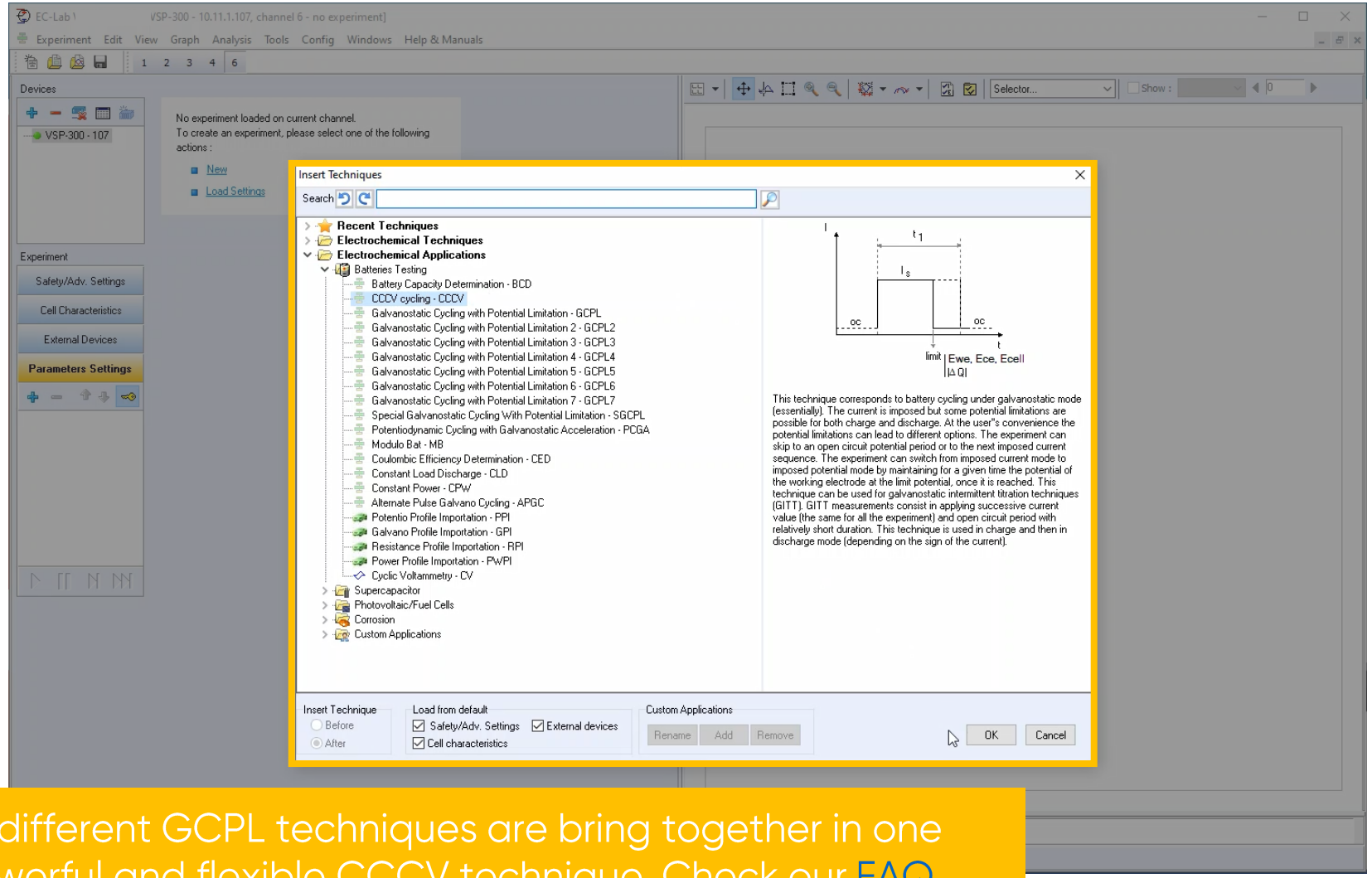


Step 1: Add CCCV technique



Step 1: Add CCCV technique

- Select CCCV technique
  - It is in the Batteries Testing folder
- Click on OK to validate

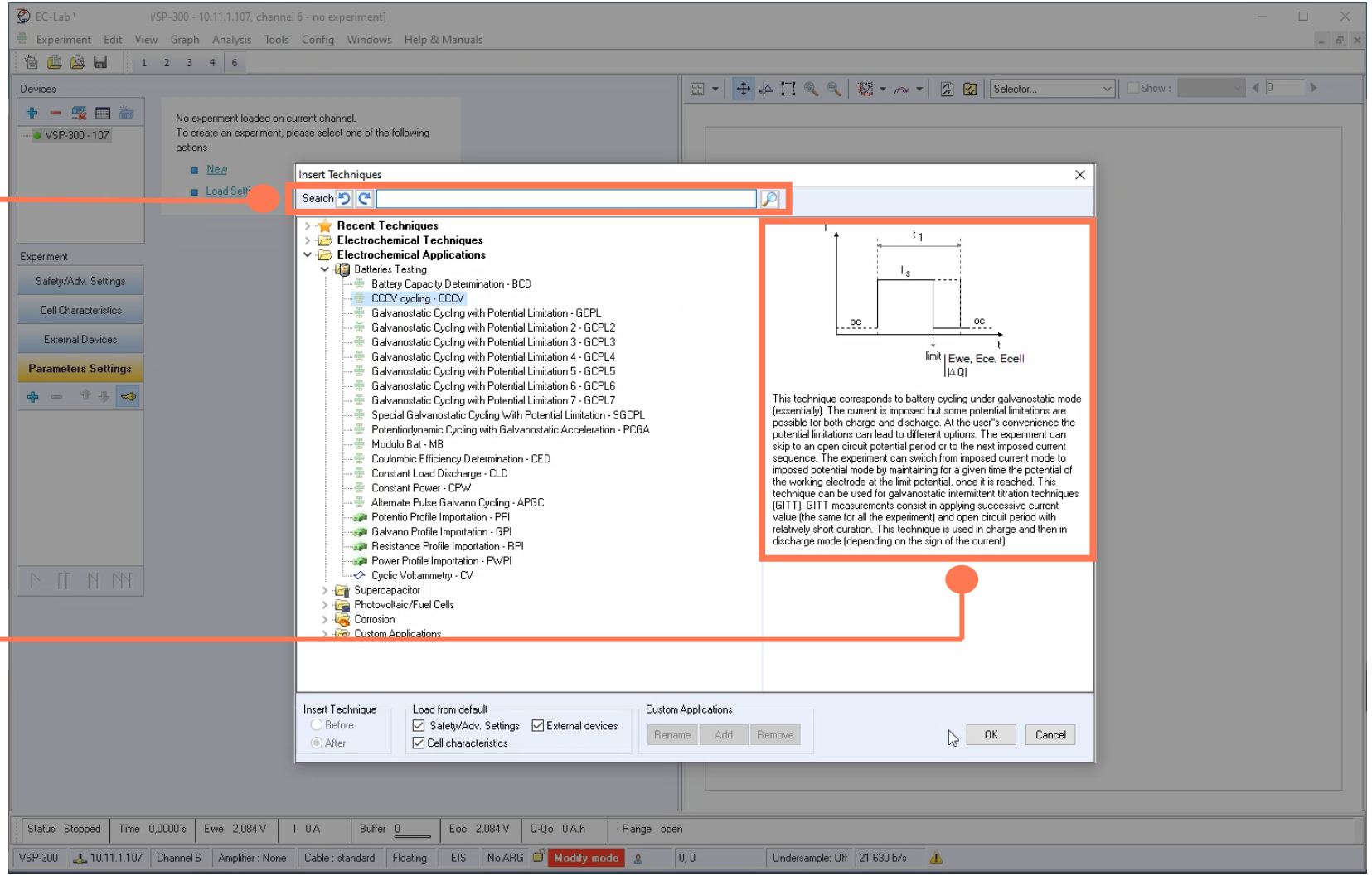


All different GCPL techniques are bring together in one powerful and flexible CCCV technique. Check our FAQ section for more detail.

Step 1: Add CCCV technique

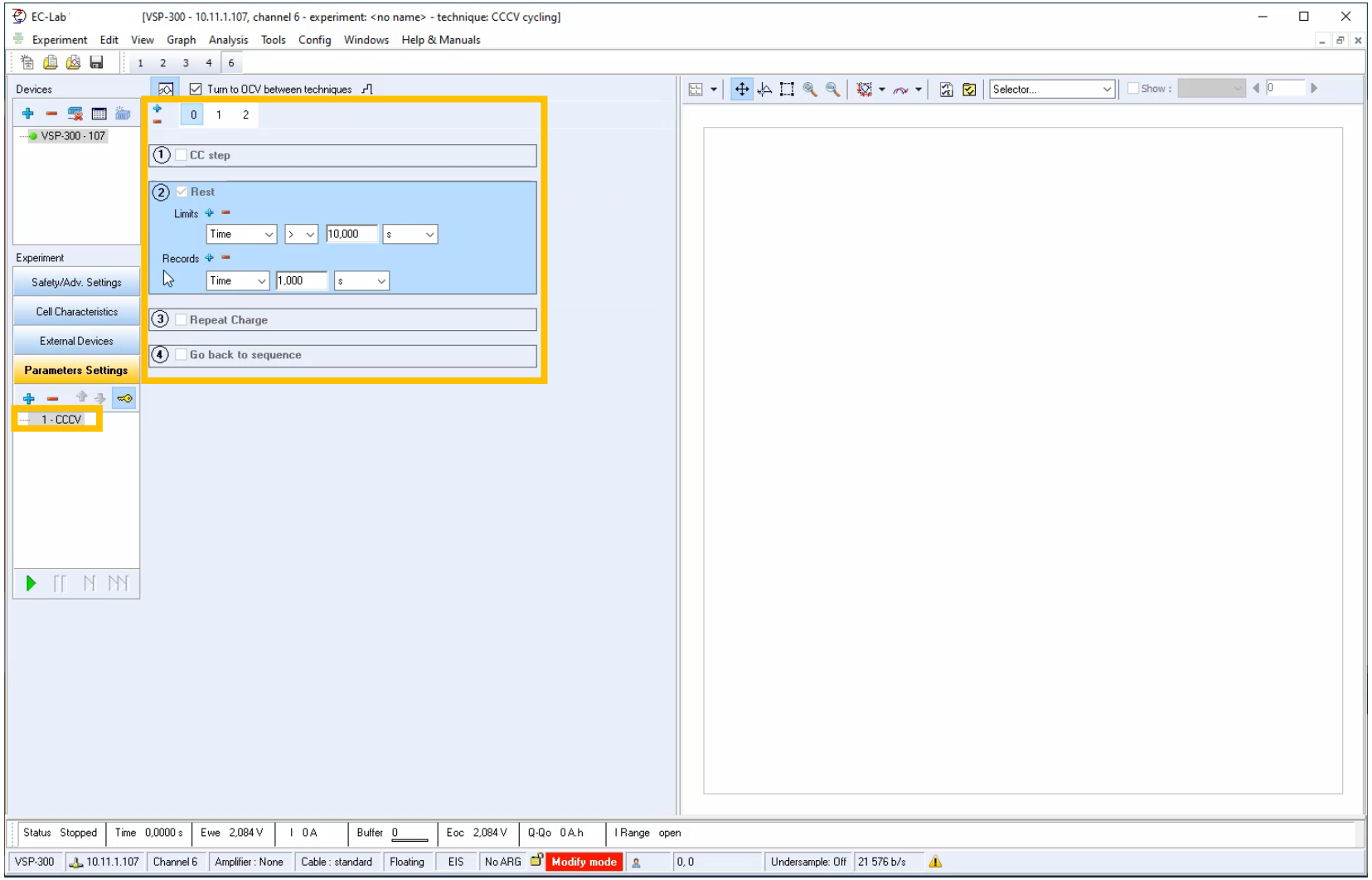
Search bar to quickly find the desired technique

Description of the technique settings and associated graph



Step 1: Add CCCV technique

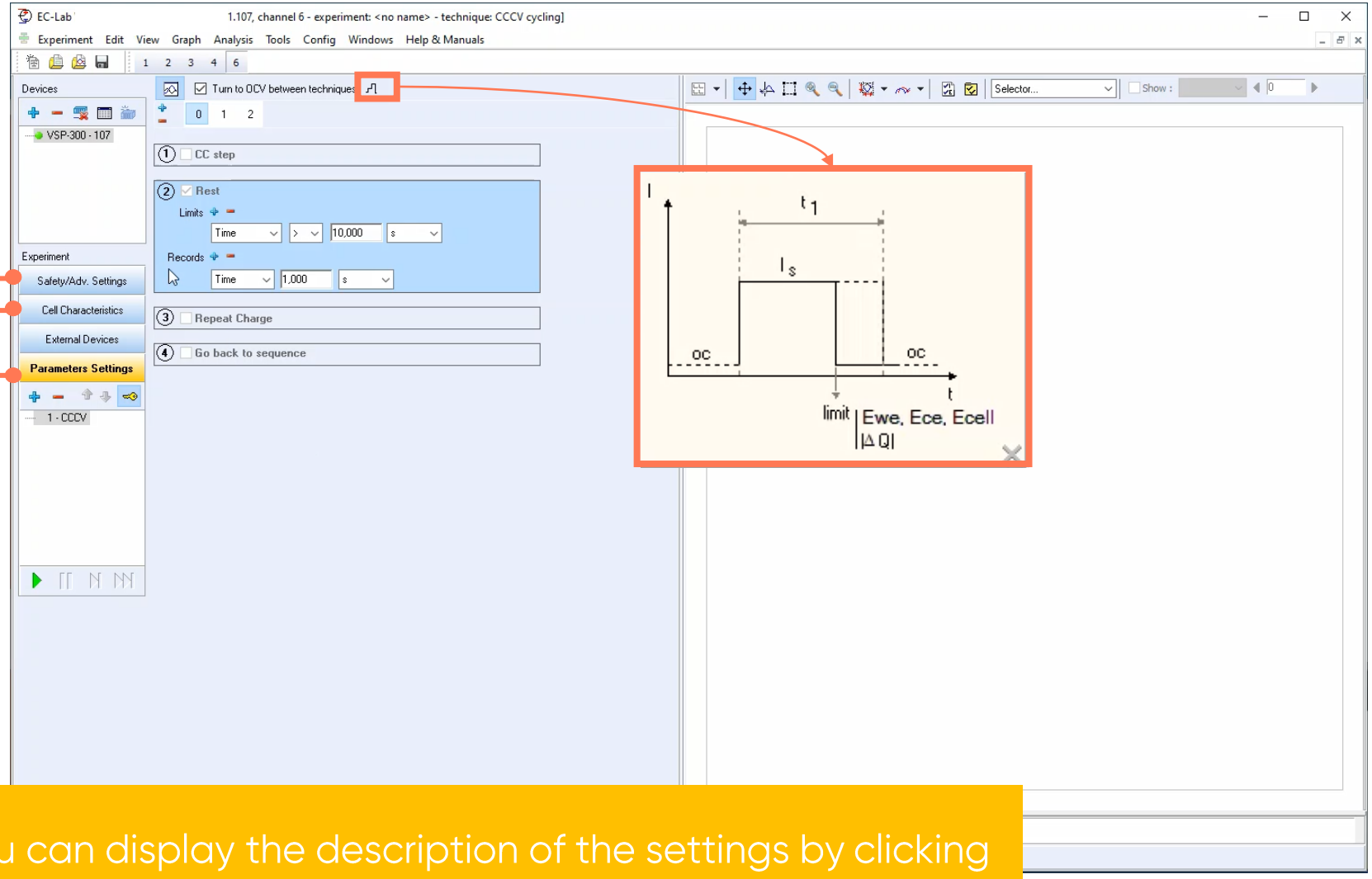
- CCCV technique is loaded in the technique list
- Corresponding CCCV parameters settings appear



Step 1: Add CCCV technique

General parameters

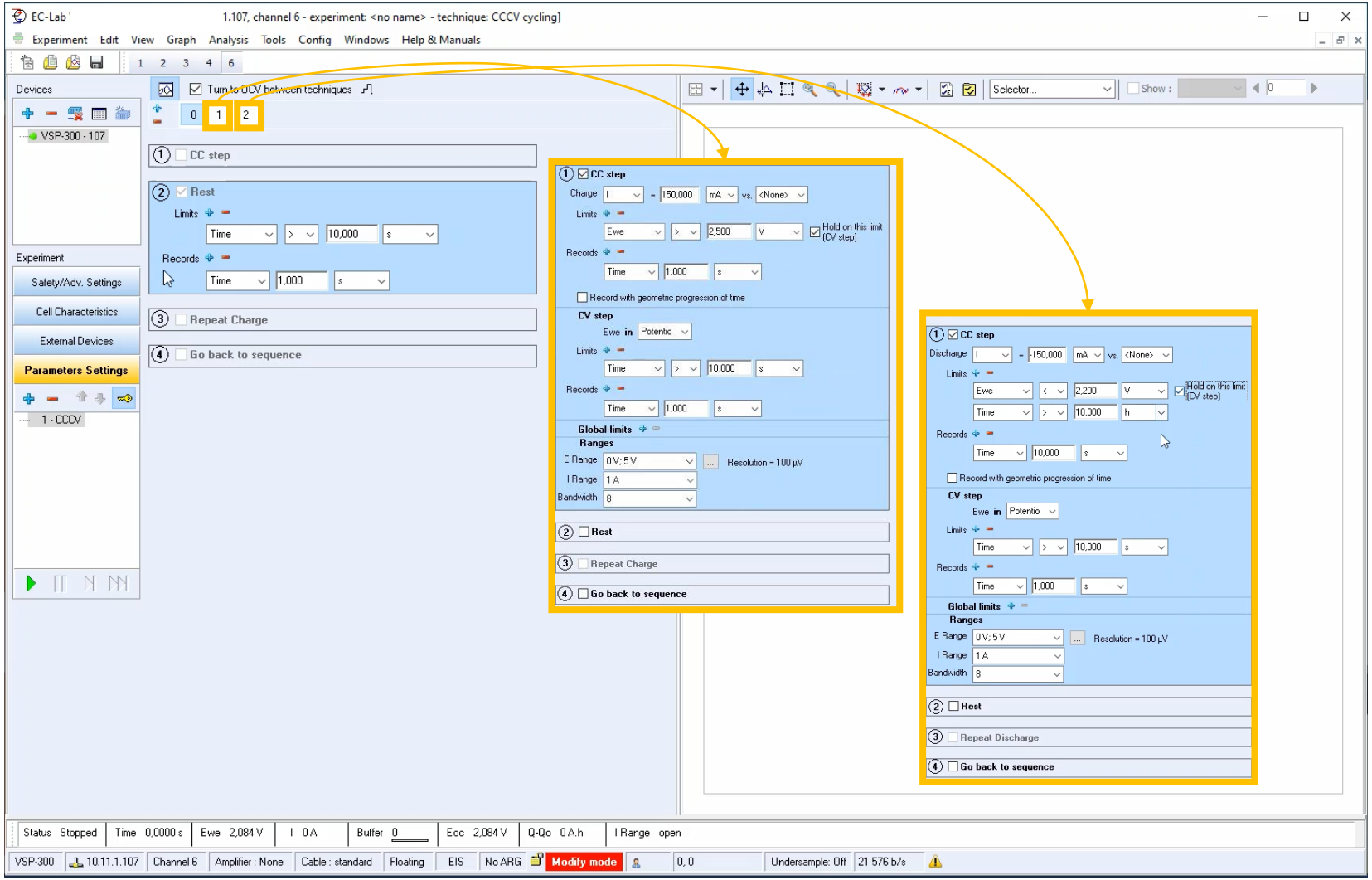
Technique parameters



You can display the description of the settings by clicking on the icon.

Step 2: Set CCCV parameters

- By default, 3 sequences are displayed
  - 0: Rest
  - 1: Charge
  - 2: Discharge



Step 2: Set CCCV parameters

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  - 0: Rest
  - 1: Charge
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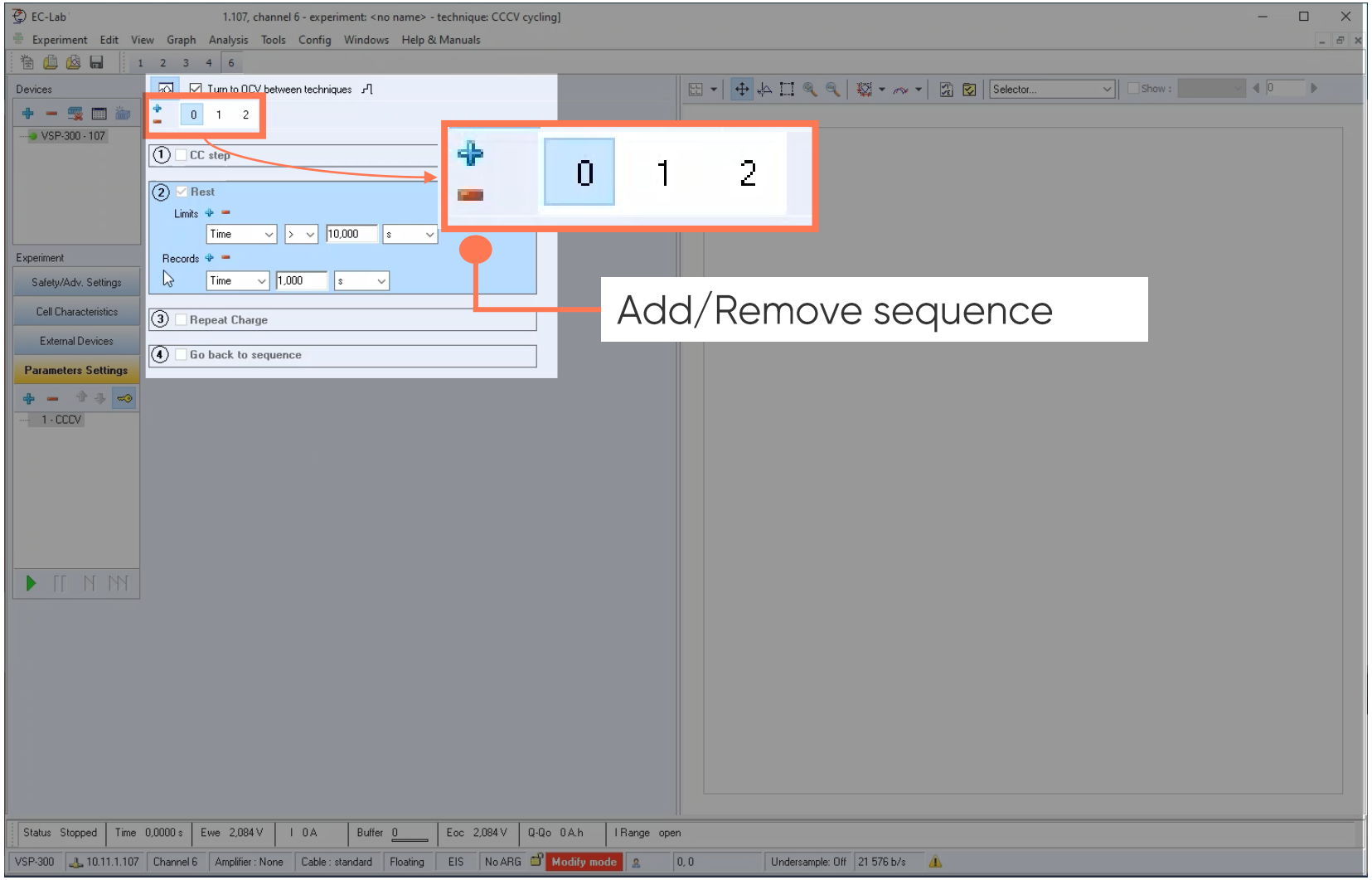
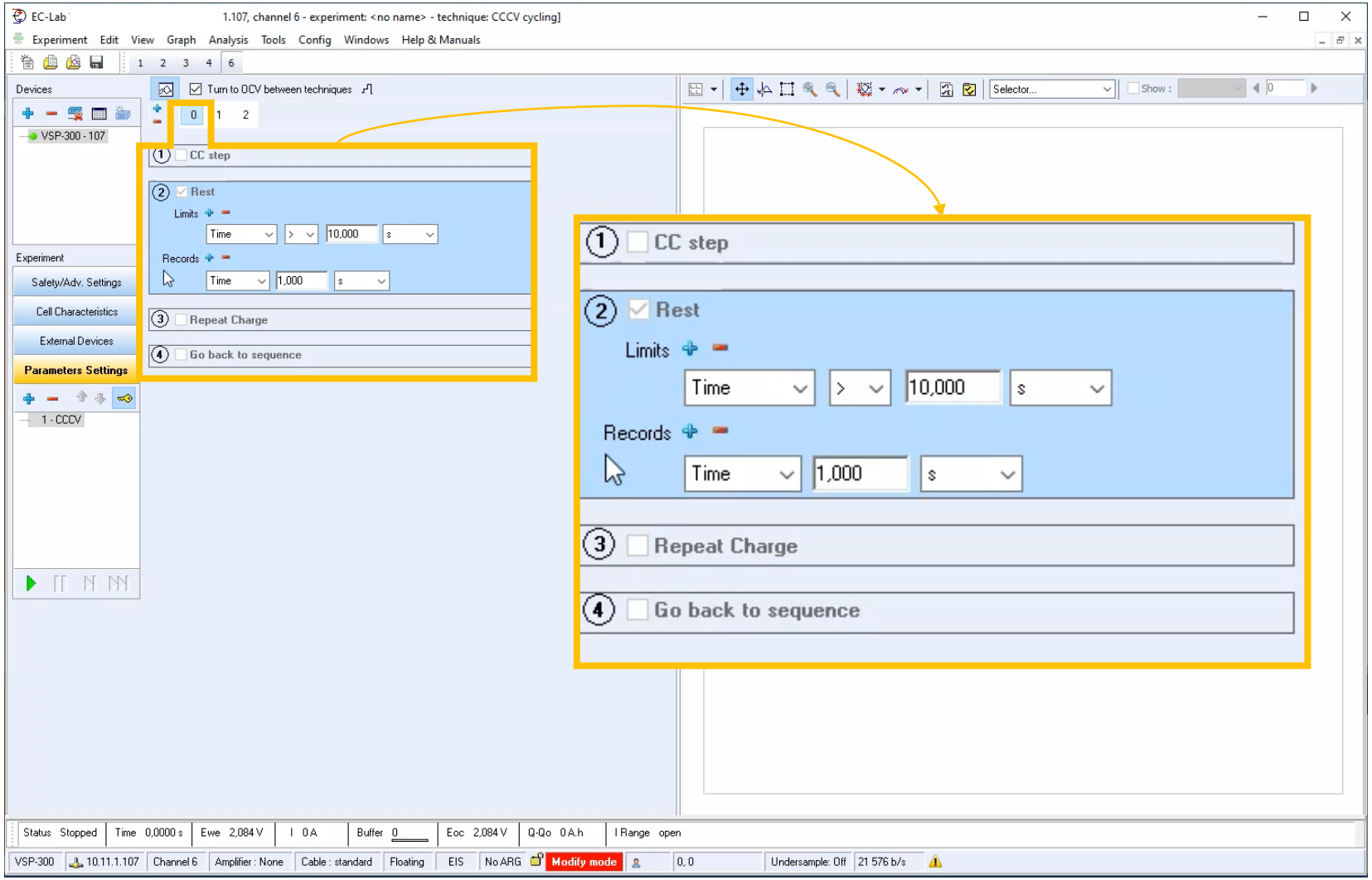


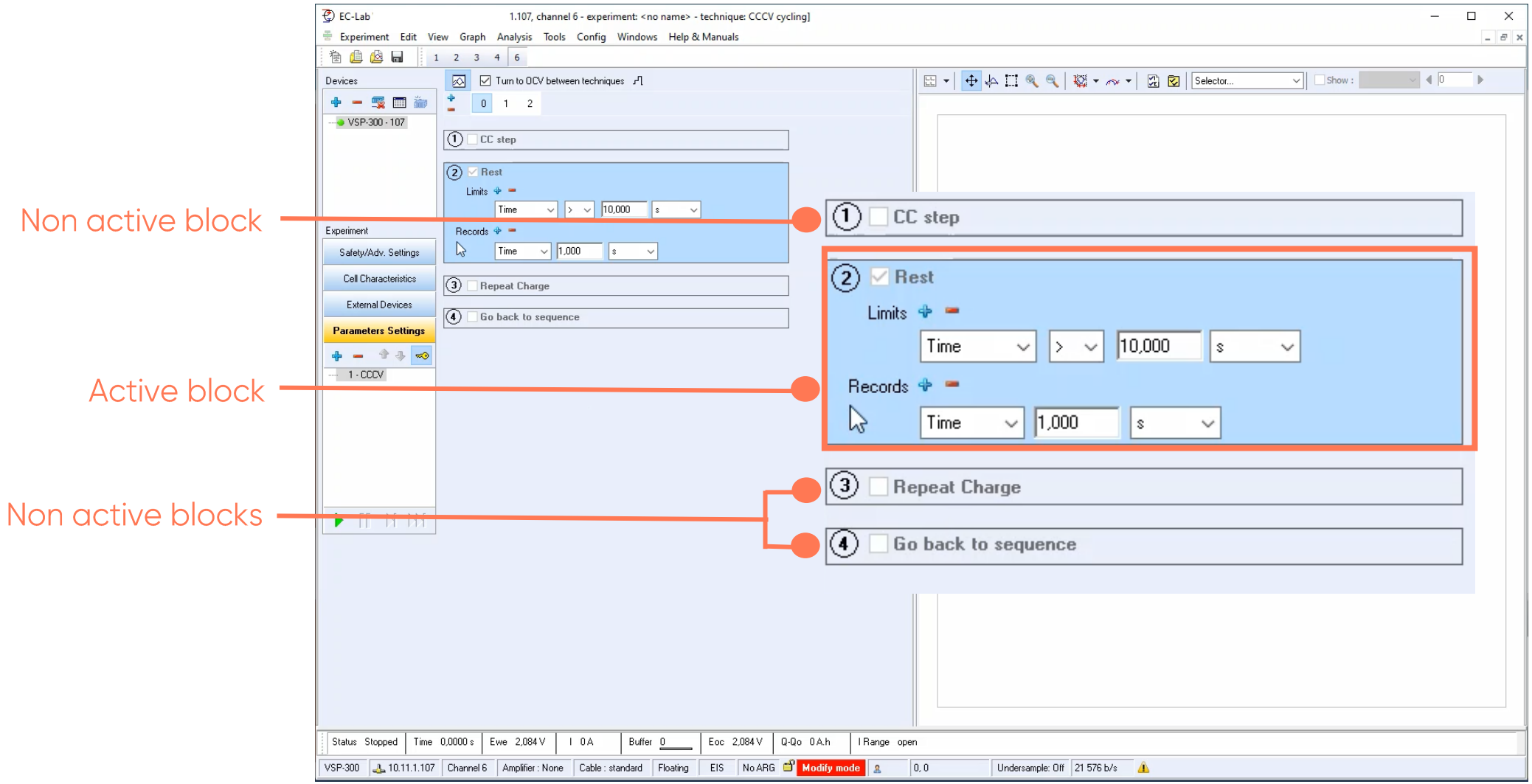
Step 2: Set CCCV parameters

- Sequence 0 is a rest period



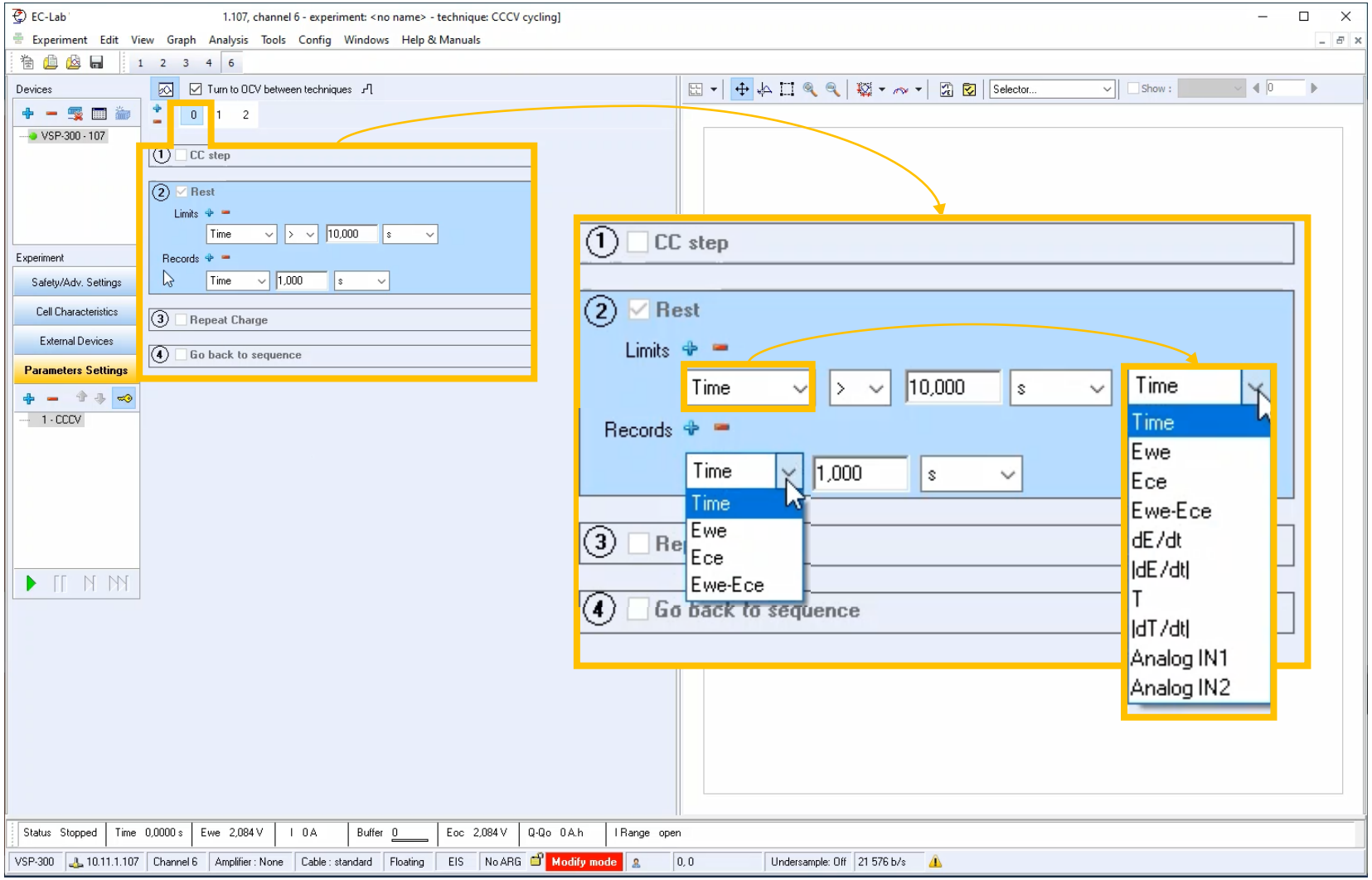
Note: Sequence 0 can't be removed

Step 2: Set CCCV parameters



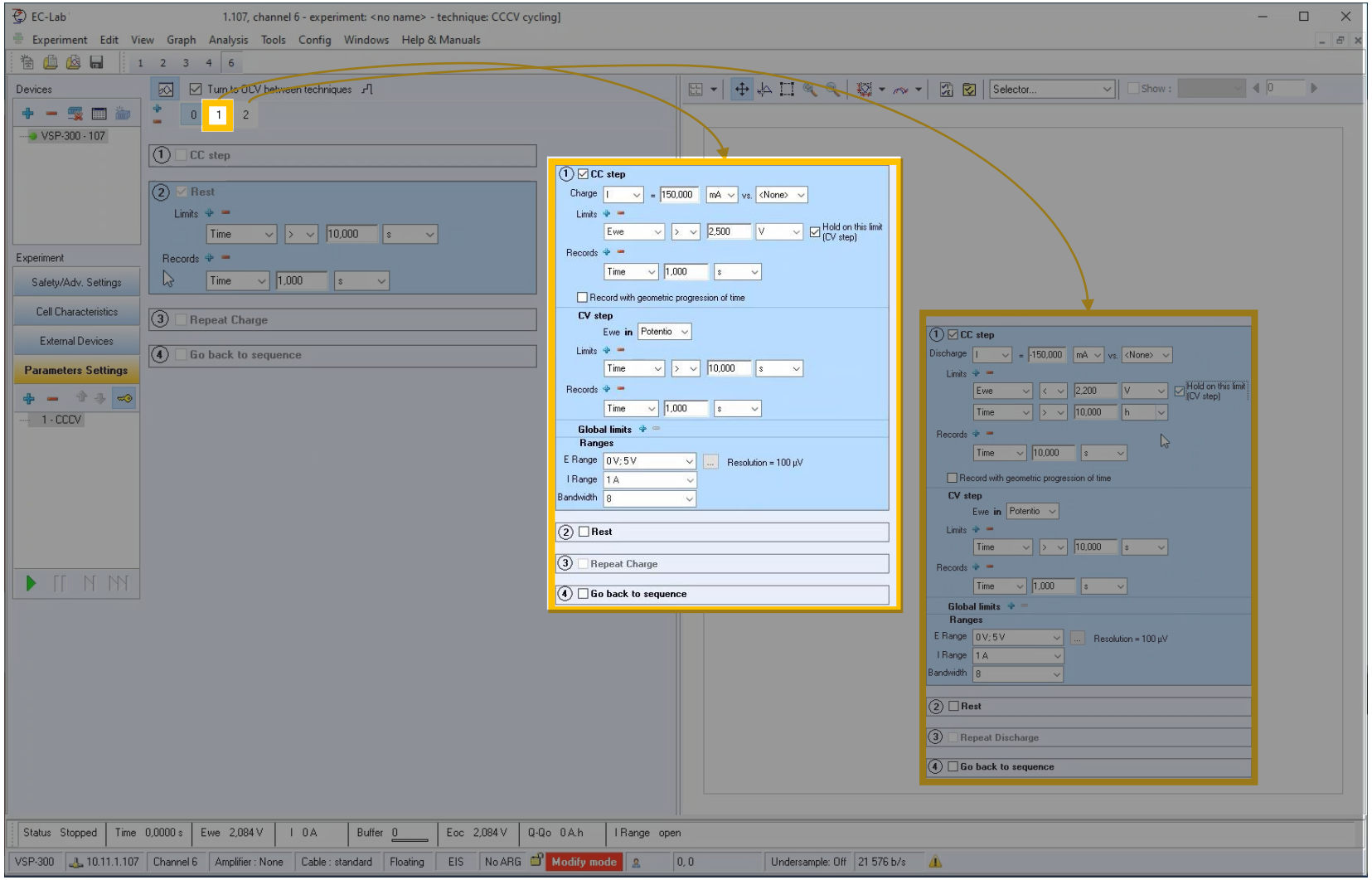
Step 2: Set CCCV parameters

- Select limit(s) type and value
- Select record type and value



Step 2: Set CCCV parameters

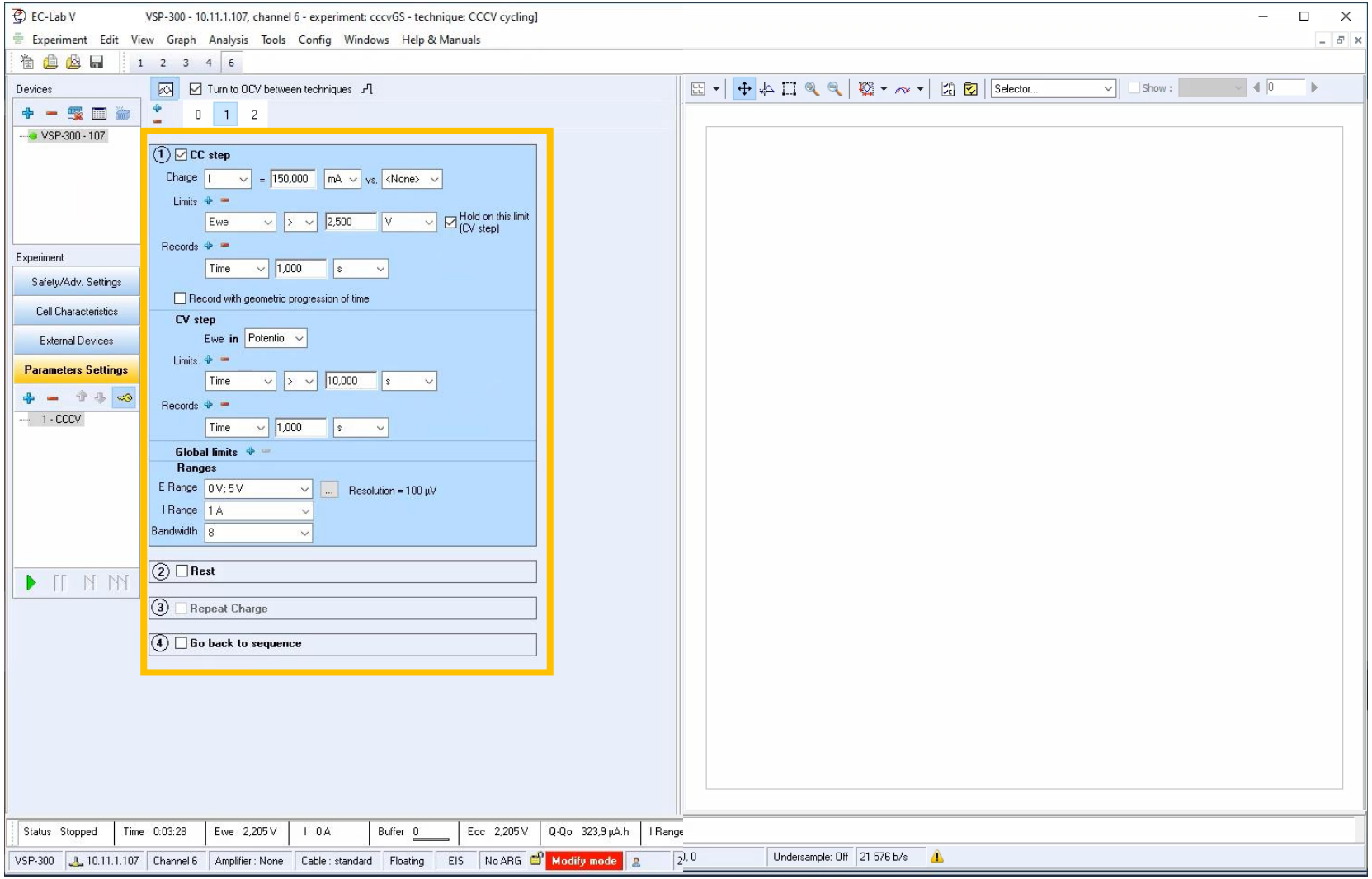
- Click on « 1 » to display sequence « 1 »



Note: Sequence 1 and 2 are designed in the same way

Step 2: Set CCCV parameters

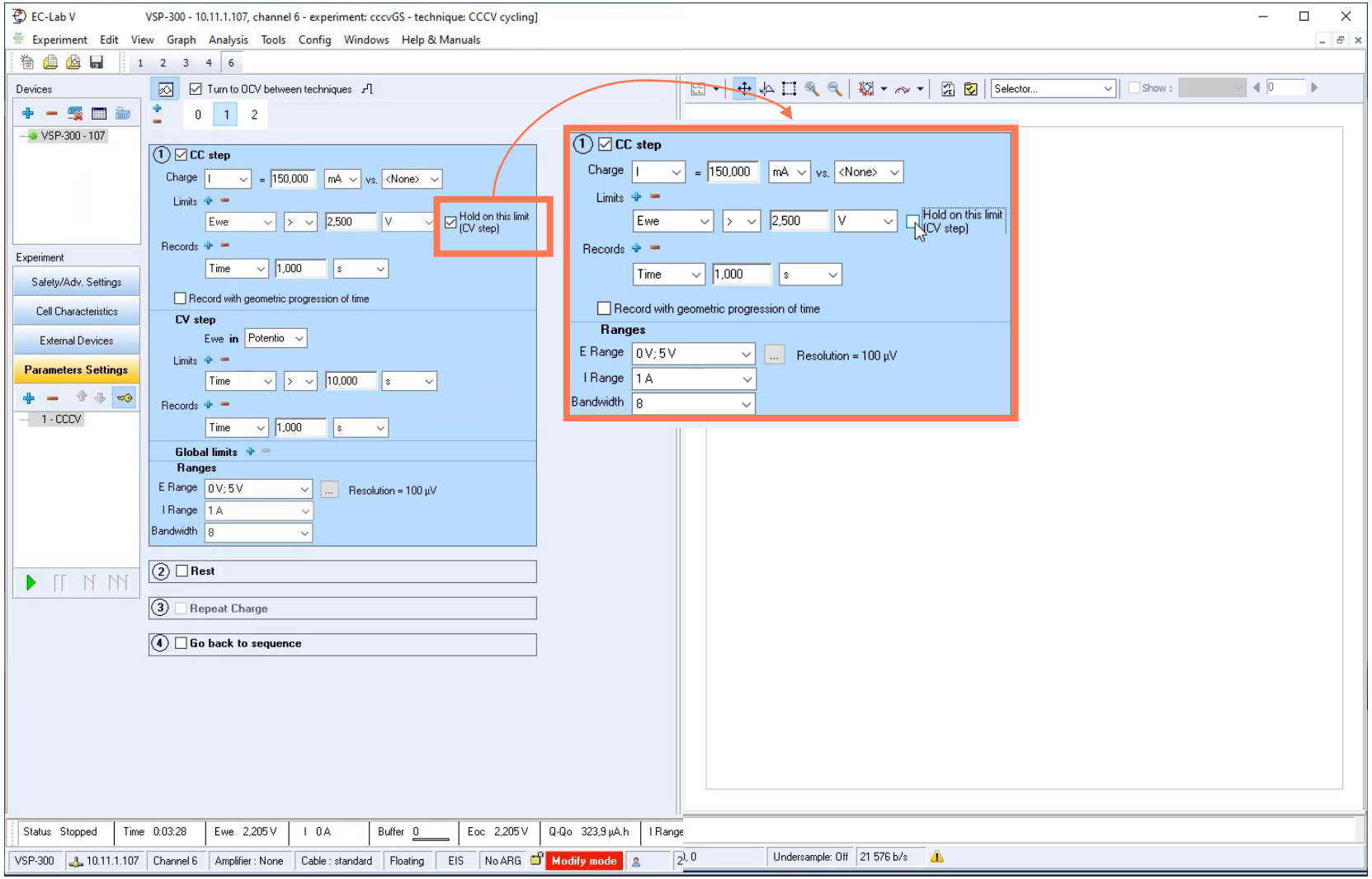
- Sequence:
  - CC step
  - (CV step)
  - Rest
    - Repeat
  - Go back to



Note: Repeat allows to go back to beginning of sequence if after Rest, required voltage is not reached (steady-state not reached)

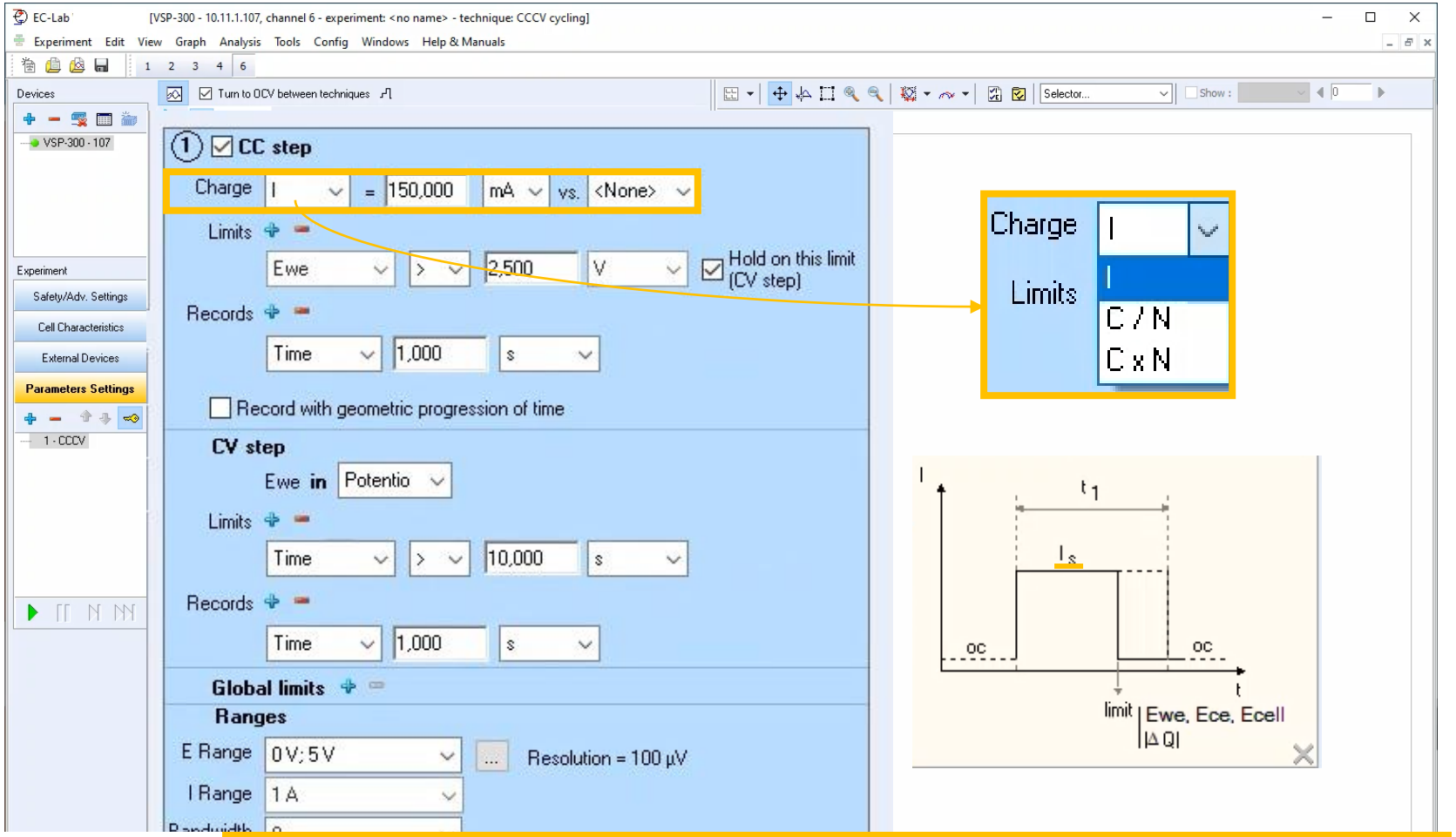
Step 2: Set CCCV parameters

- If needed, uncheck « Hold on this limit » to remove CV step



Step 2: Set CCCV parameters

- Set applied current



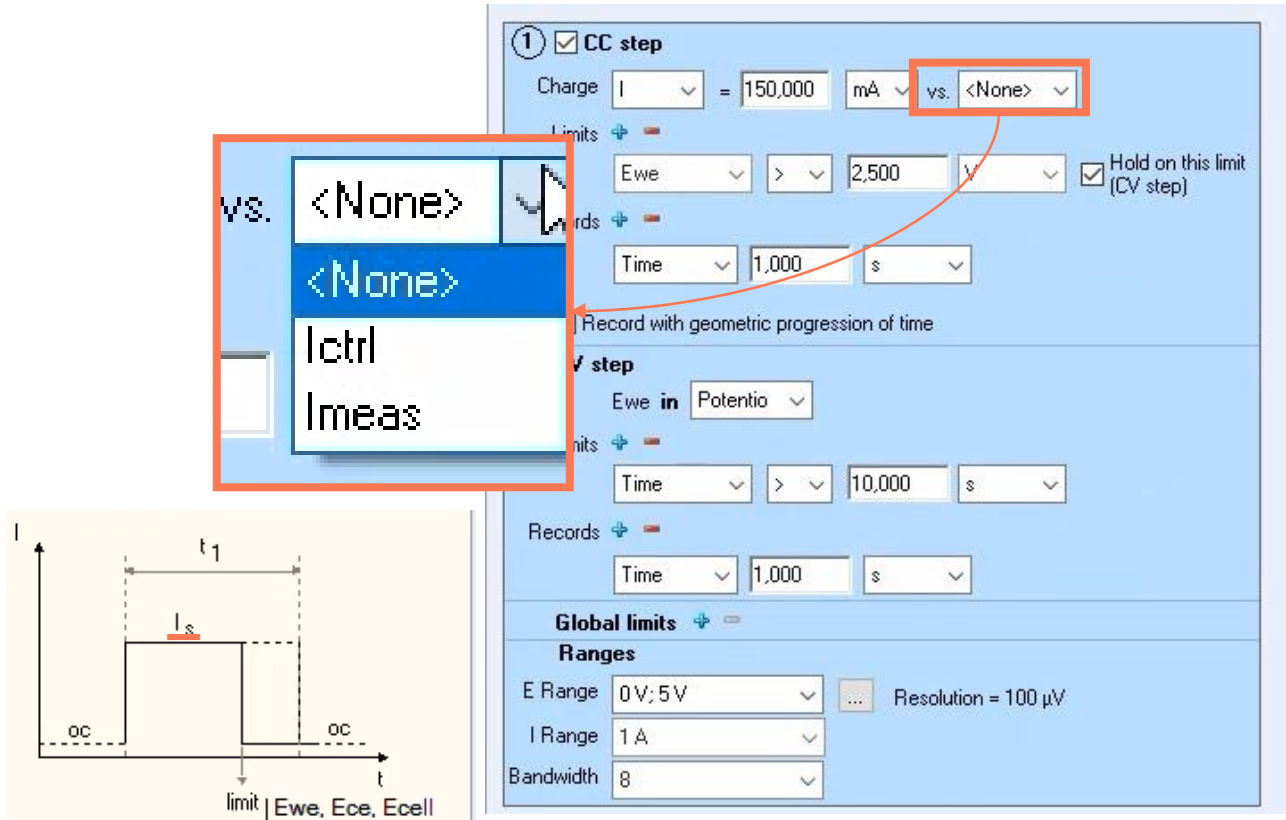
Note: Add « - » to the value to change from charge to discharge

If the capacity of the battery is defined in Cell characteristics, the user may select a rate instead of a current.

Step 2: Set CCCV parameters

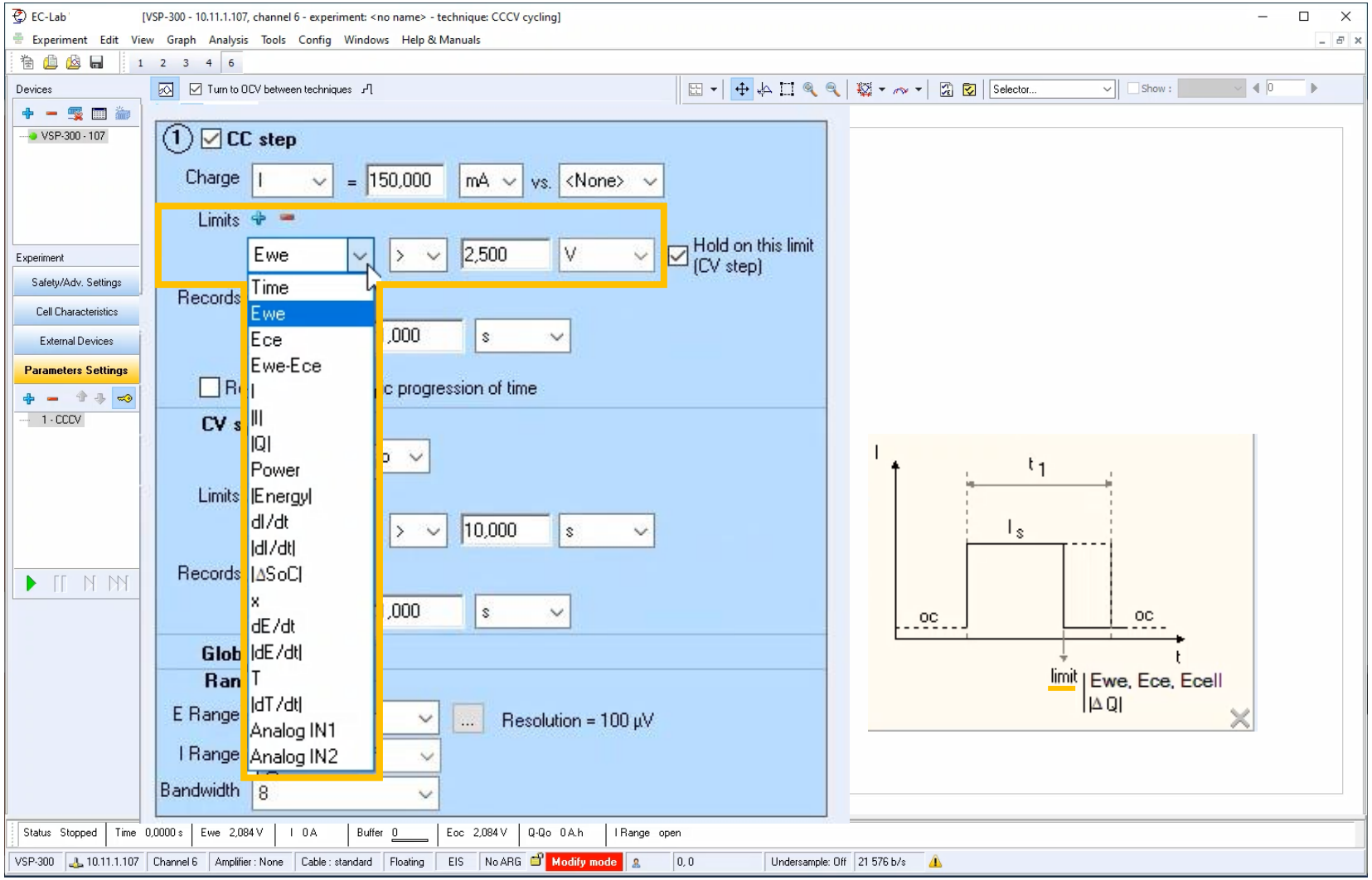
Define I versus voltage of:

- **Ictrl:** the previous controlled current, if a technique is set before the CCCV
- **Imeas:** the previous measured current, if a technique is set before the CCCV



Step 2: Set CCCV parameters

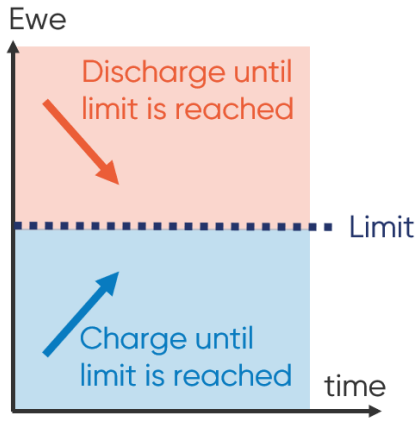
- Set limit(s) type and value

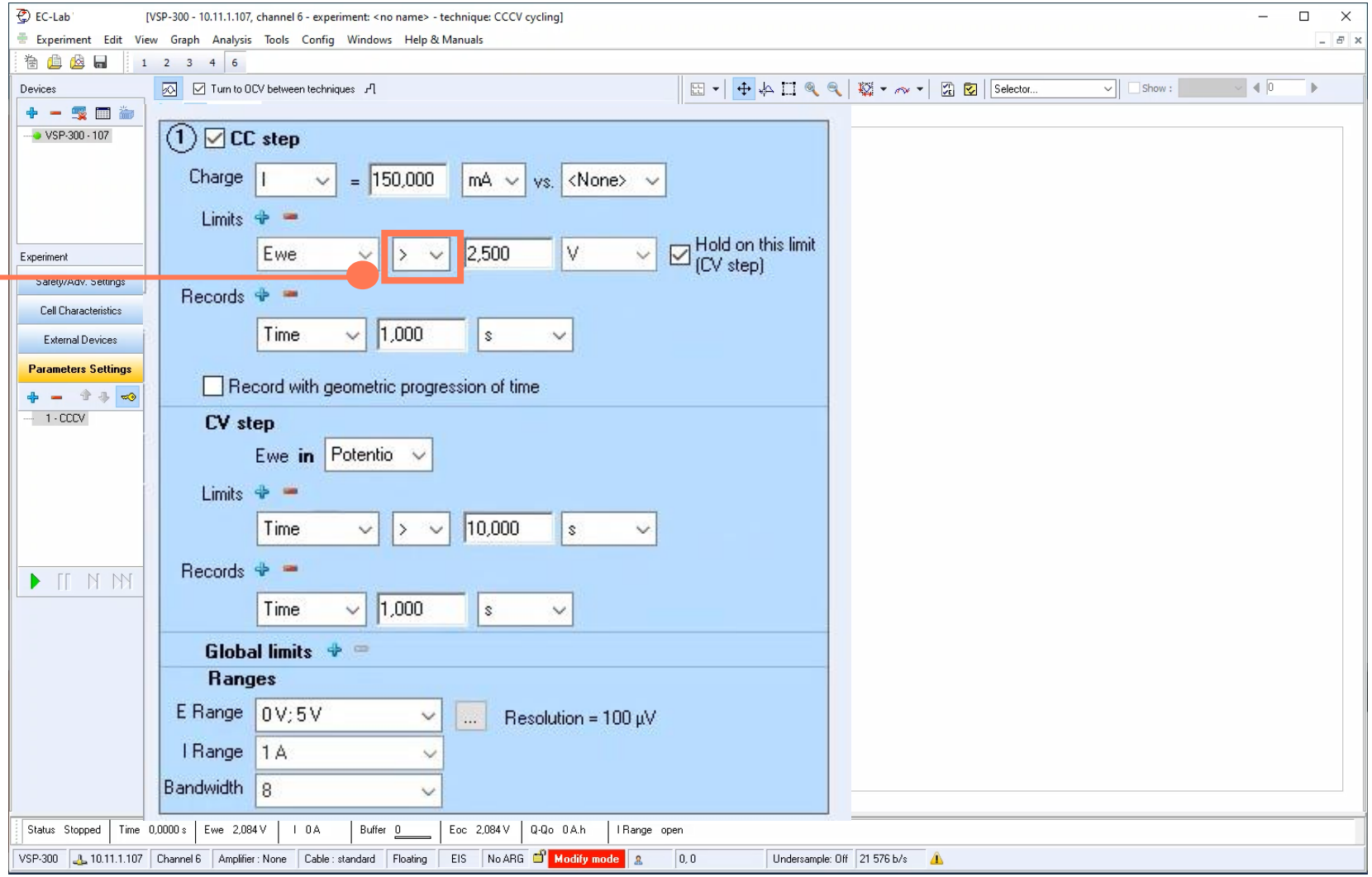


Note: By default, voltage Ewe is the limit

Step 2: Set CCCV parameters

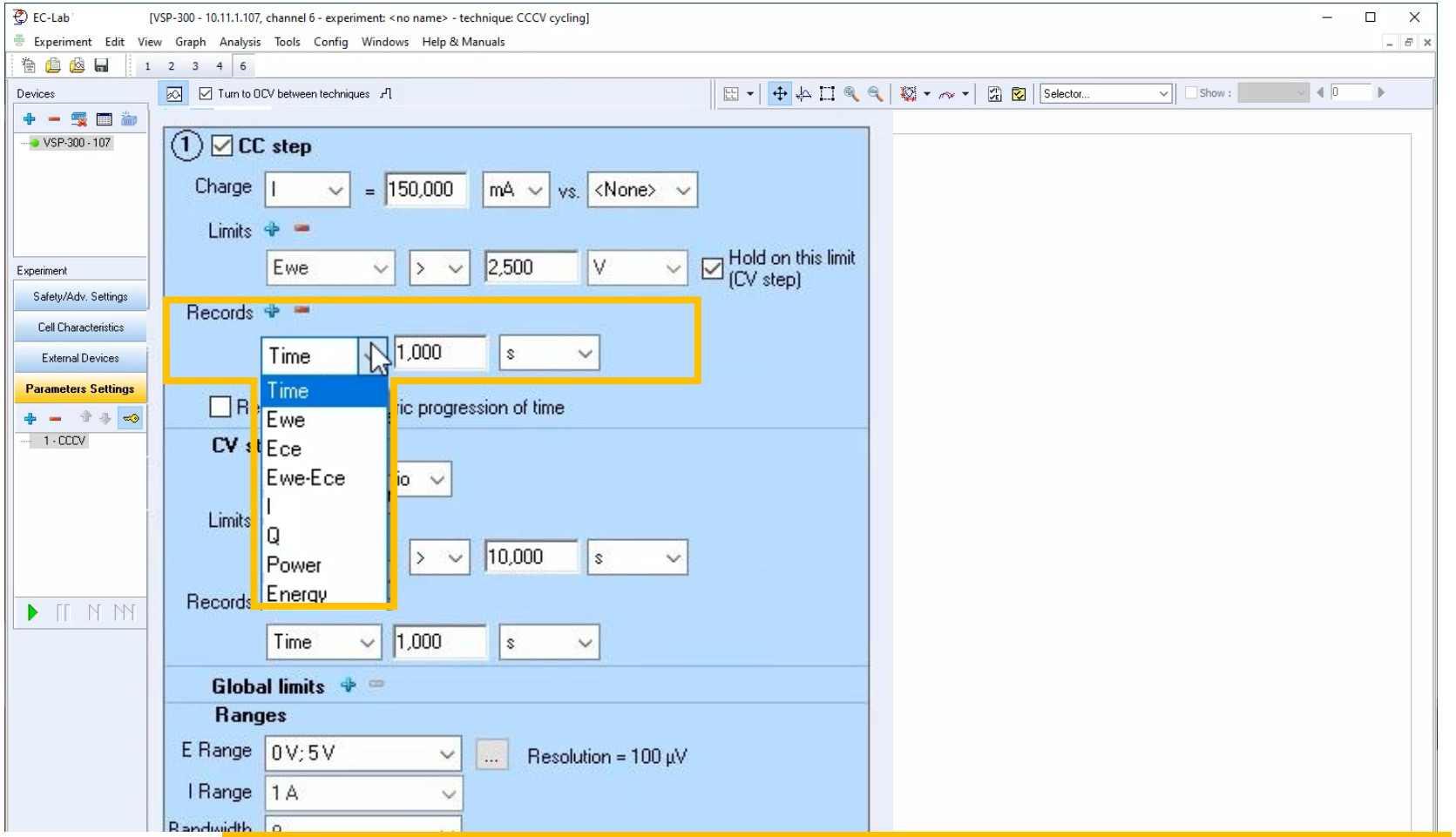
Sign is automatically updated according to the sign of the current





Step 2: Set CCCV parameters

- Set record(s) type and value

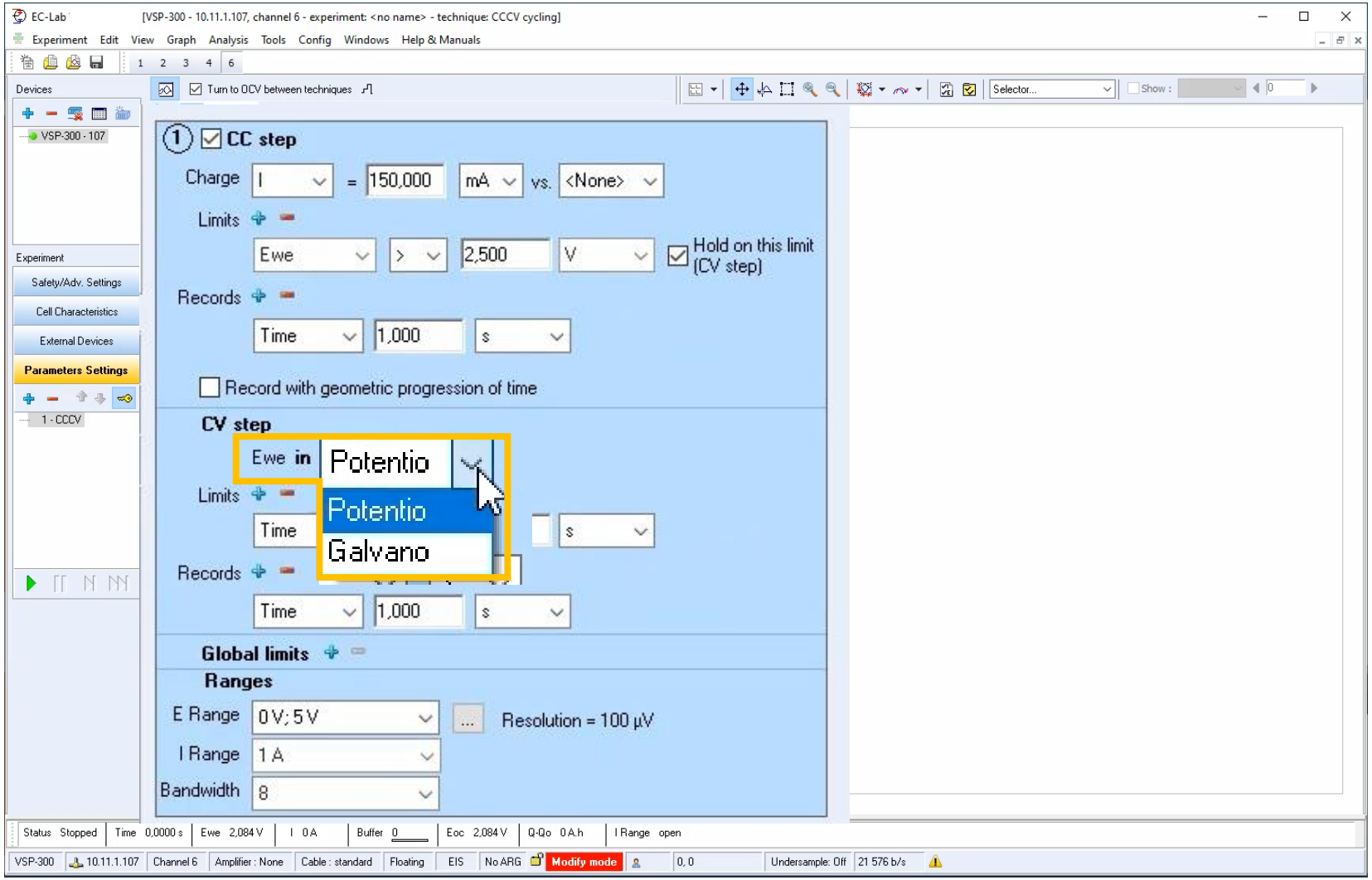


Note: By default, it is recorded in time

As battery testing may take several months, only the relevant points can be recorded (i.e. variations) depending on selected sampling rate.

Step 2: Set CCCV parameters

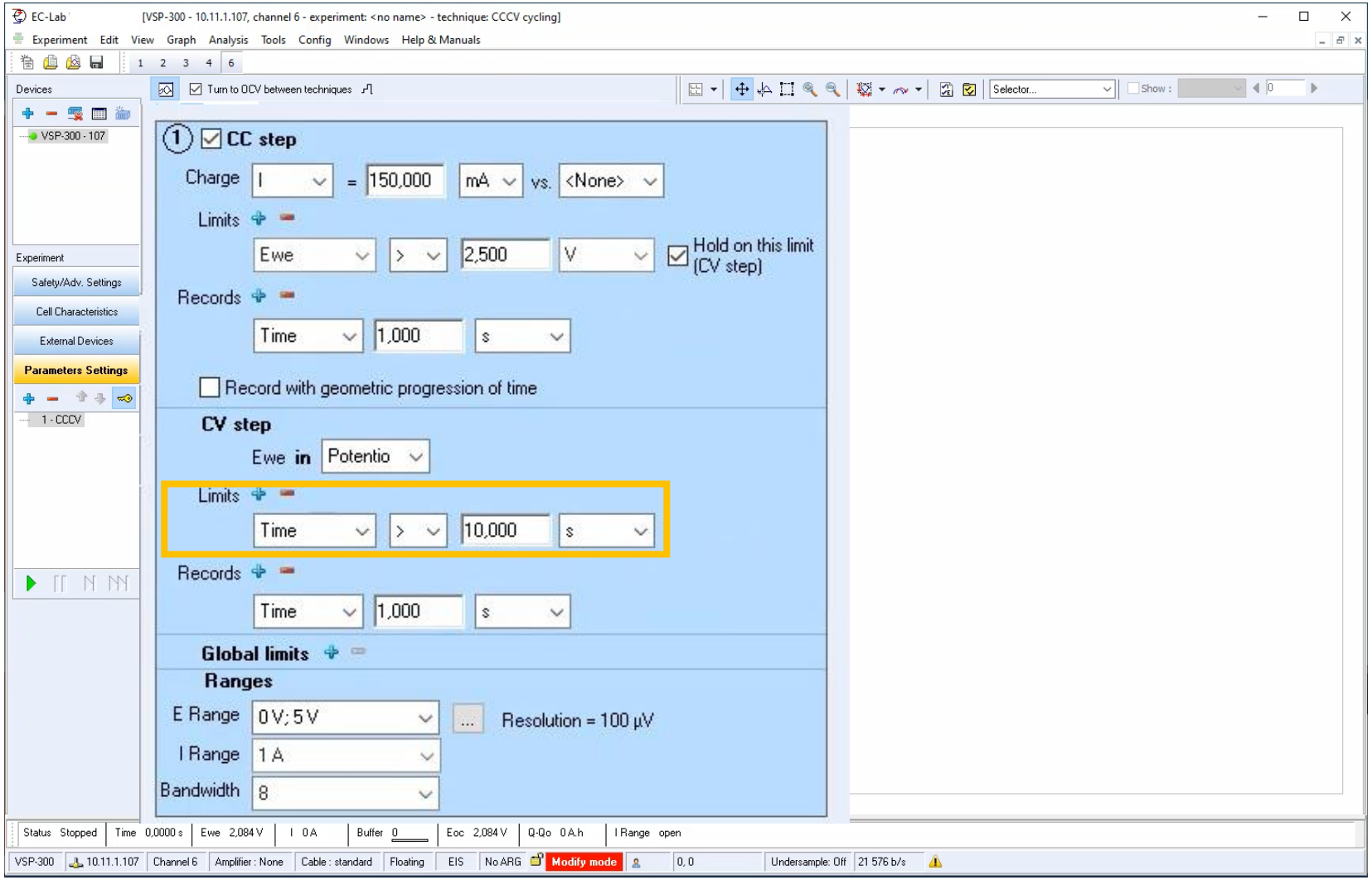
- Select control mode for CV step



Note: By default, it is potentio

Step 2: Set CCCV parameters

- Set limit(s) type and value

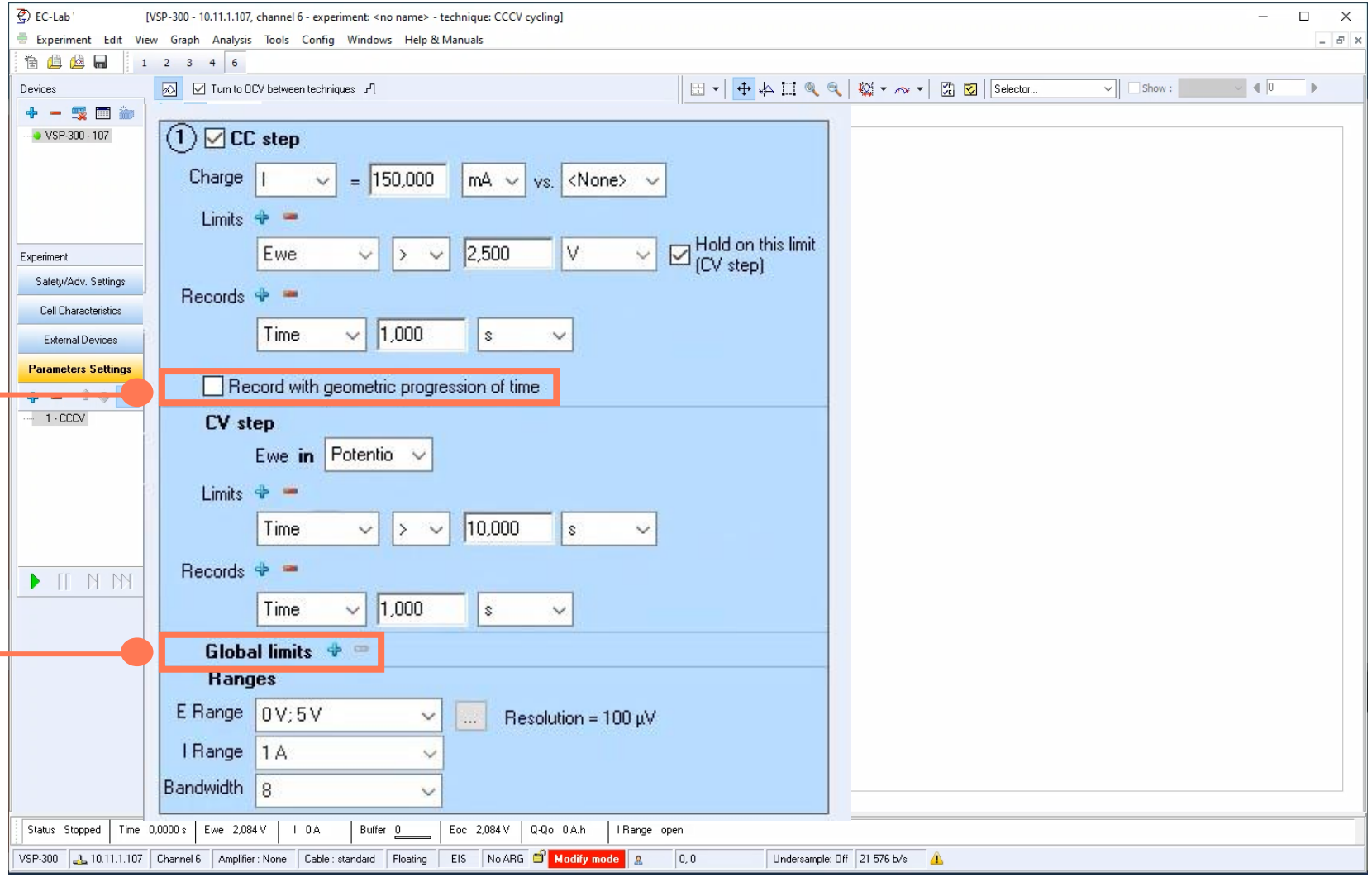


Note: By default, the limit is time

Step 2: Set CCCV parameters

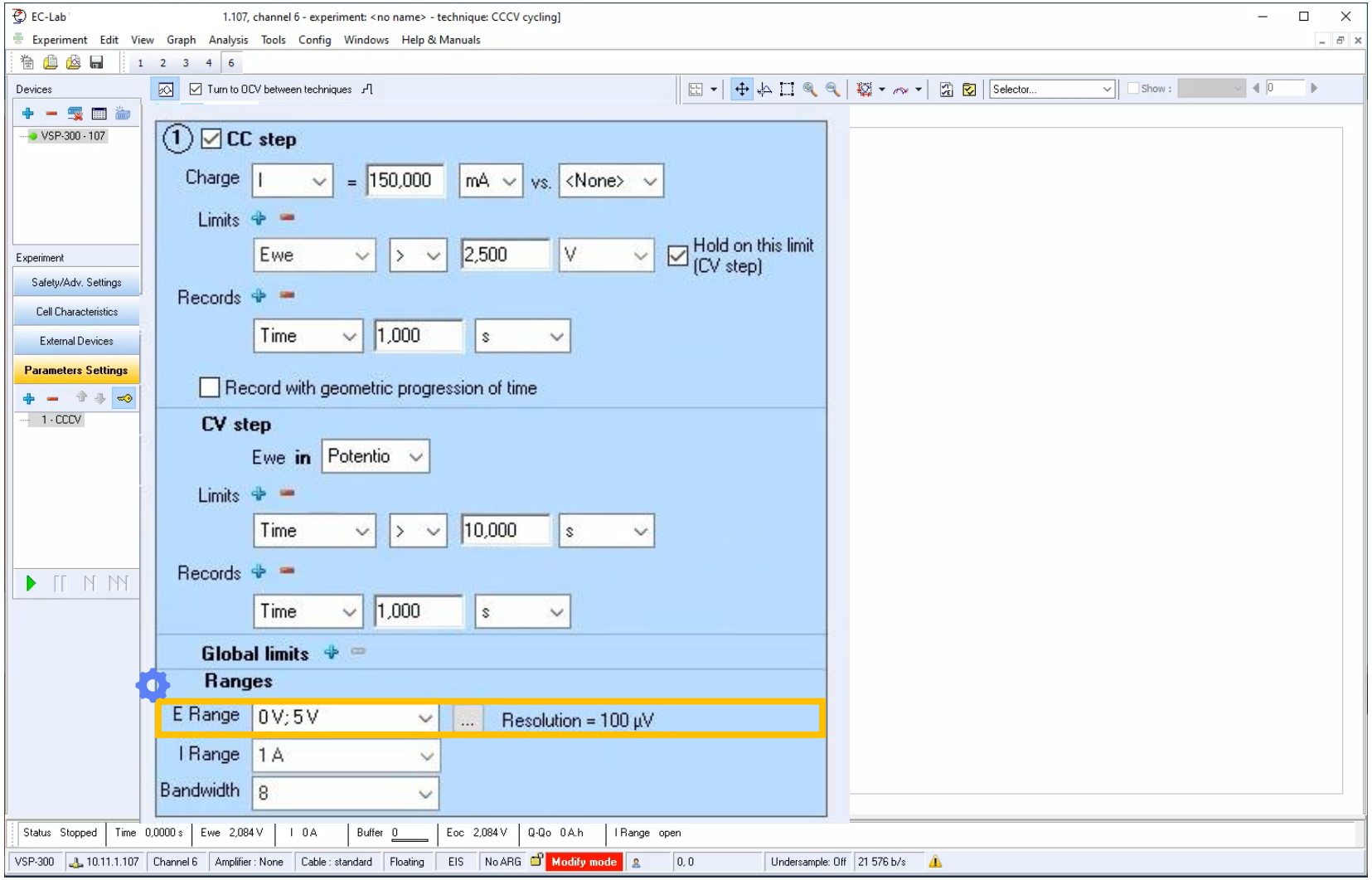
Fast sampling rate at the beginning
(to process the apparent resistance)

Global limits are applied to the whole sequence



Step 3: Optimize the measurement

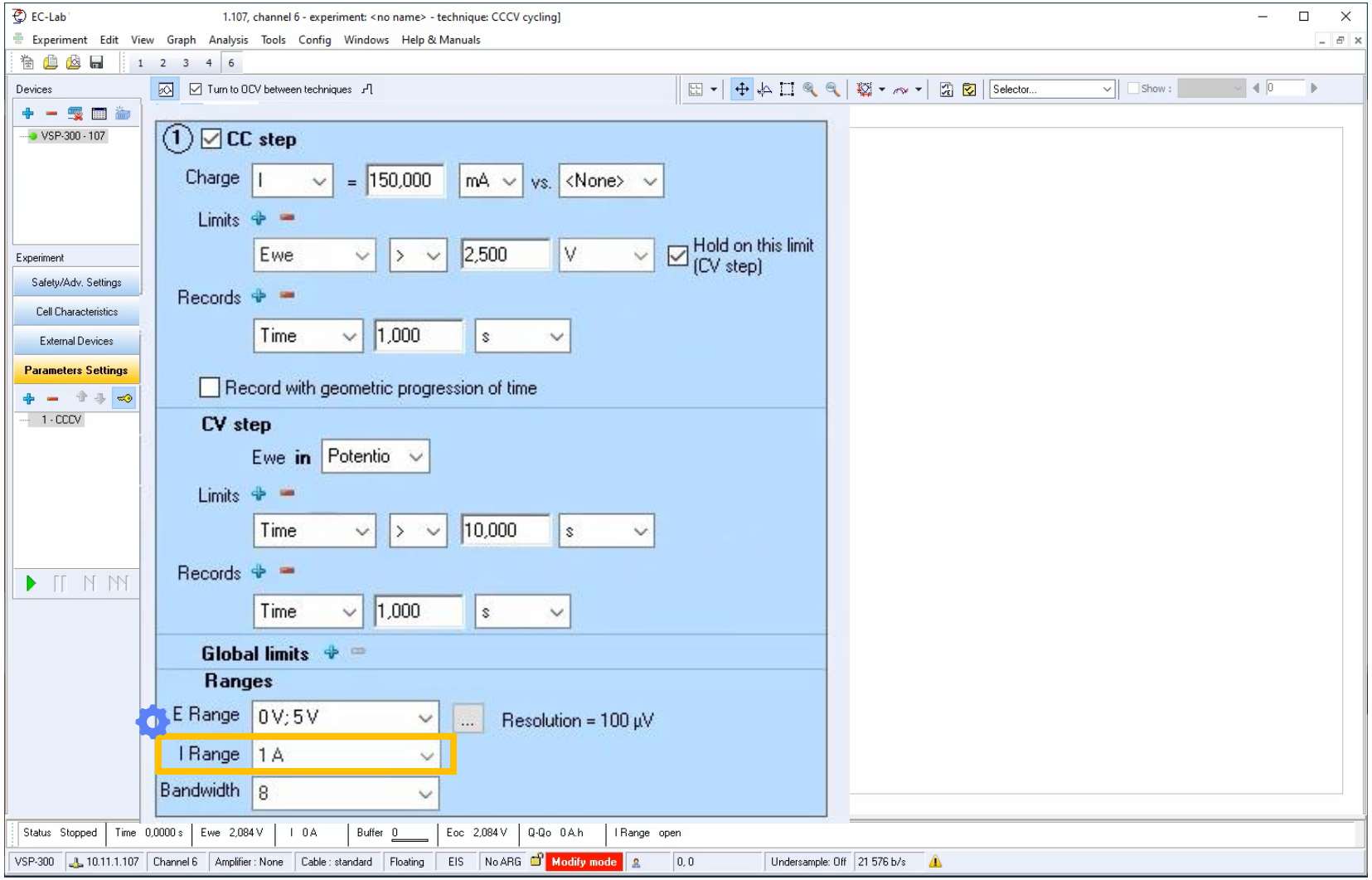
- E Range is the range of expected voltage



E Range has to be wide enough to be in the range of the operating voltage of the battery but narrow enough to get an optimized resolution in the voltage measurement/control

Step 3: Optimize the measurement

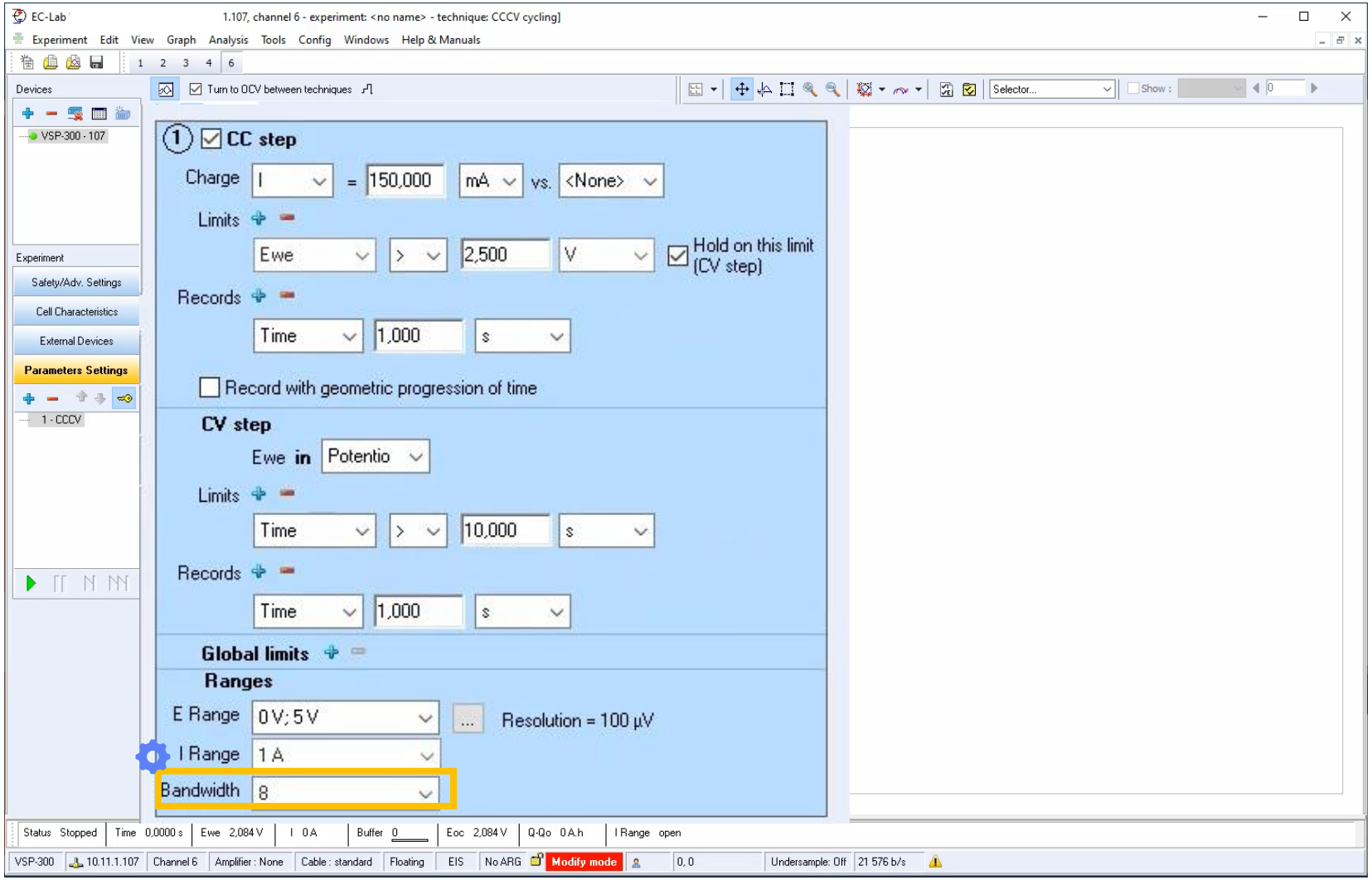
- I Range is the range of expected current
- Autorange is available



Autorange optimizes current and enables to perform charge/discharge cycles at different C-rates within the same technique

Step 3: Optimize the measurement

- Adjust bandwith to make sure potentiostat controls the cell in stable and fast way

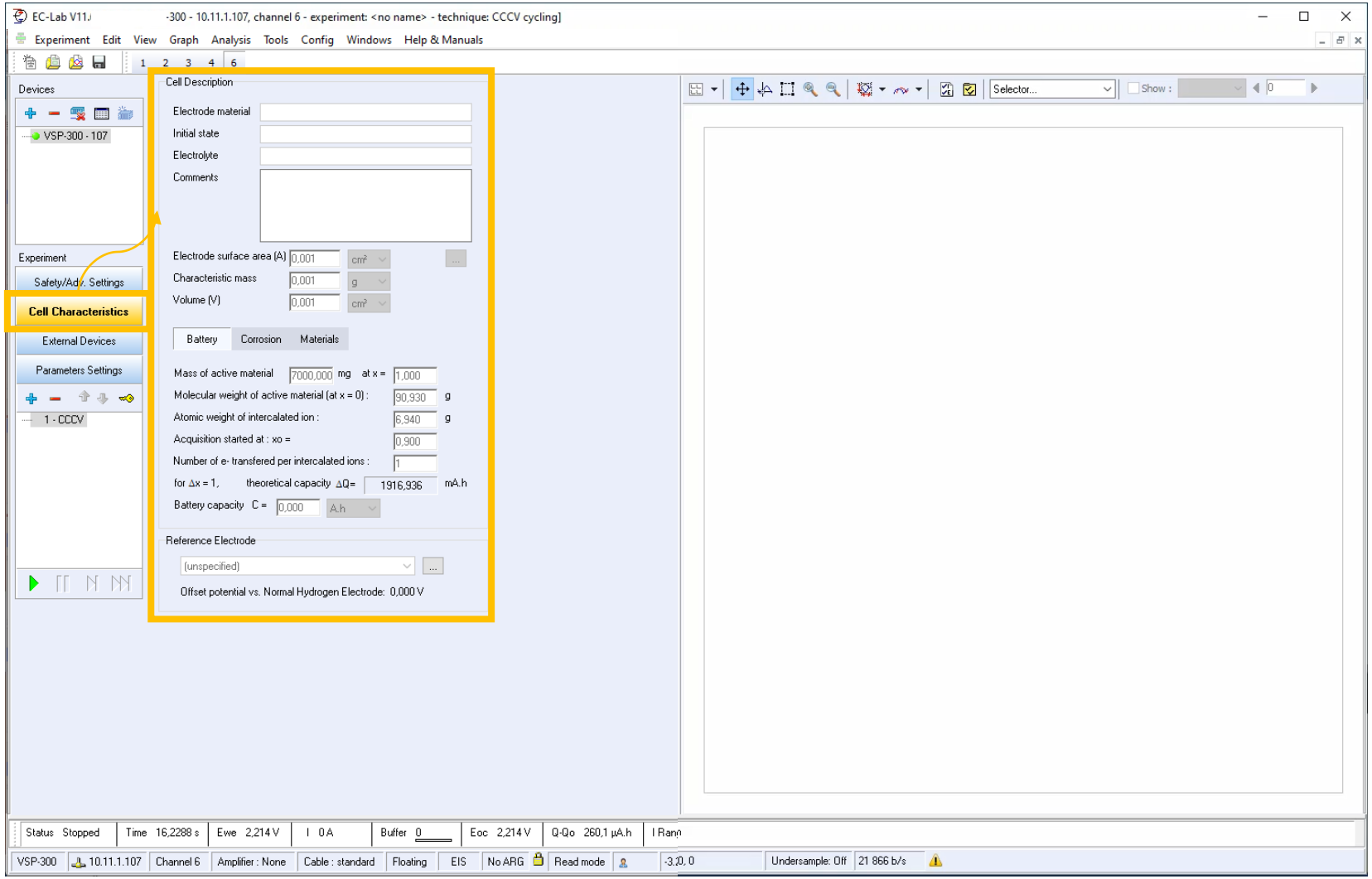


As battery have slow response, a slow bandwidth is appropriate.

- 5-slow for Essential
- 7-slow for Premium

Step 4: Set general parameters

- Add information and comments about the cell

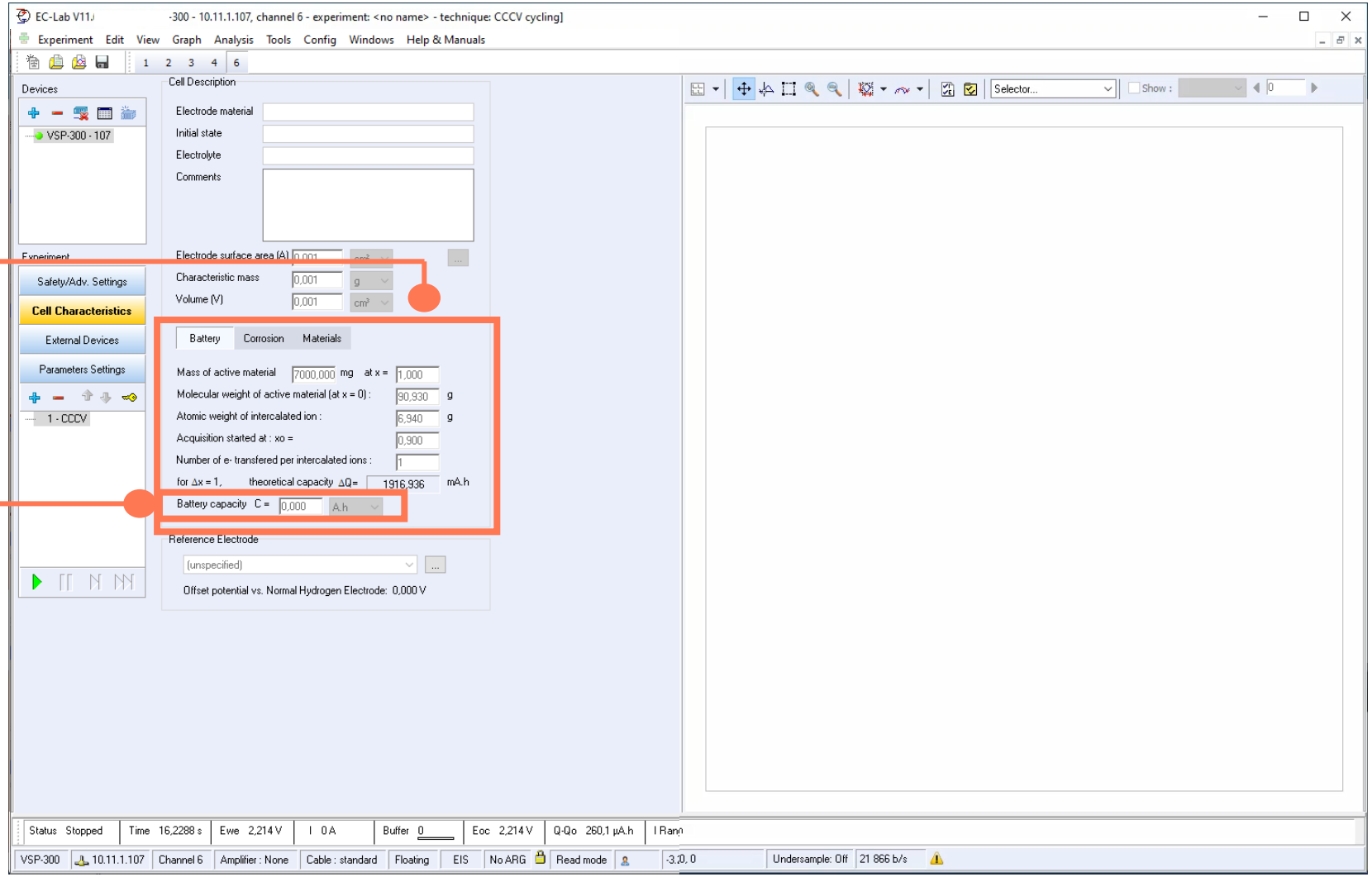


Note: All this information is stored in the data file

Step 4: Set general parameters

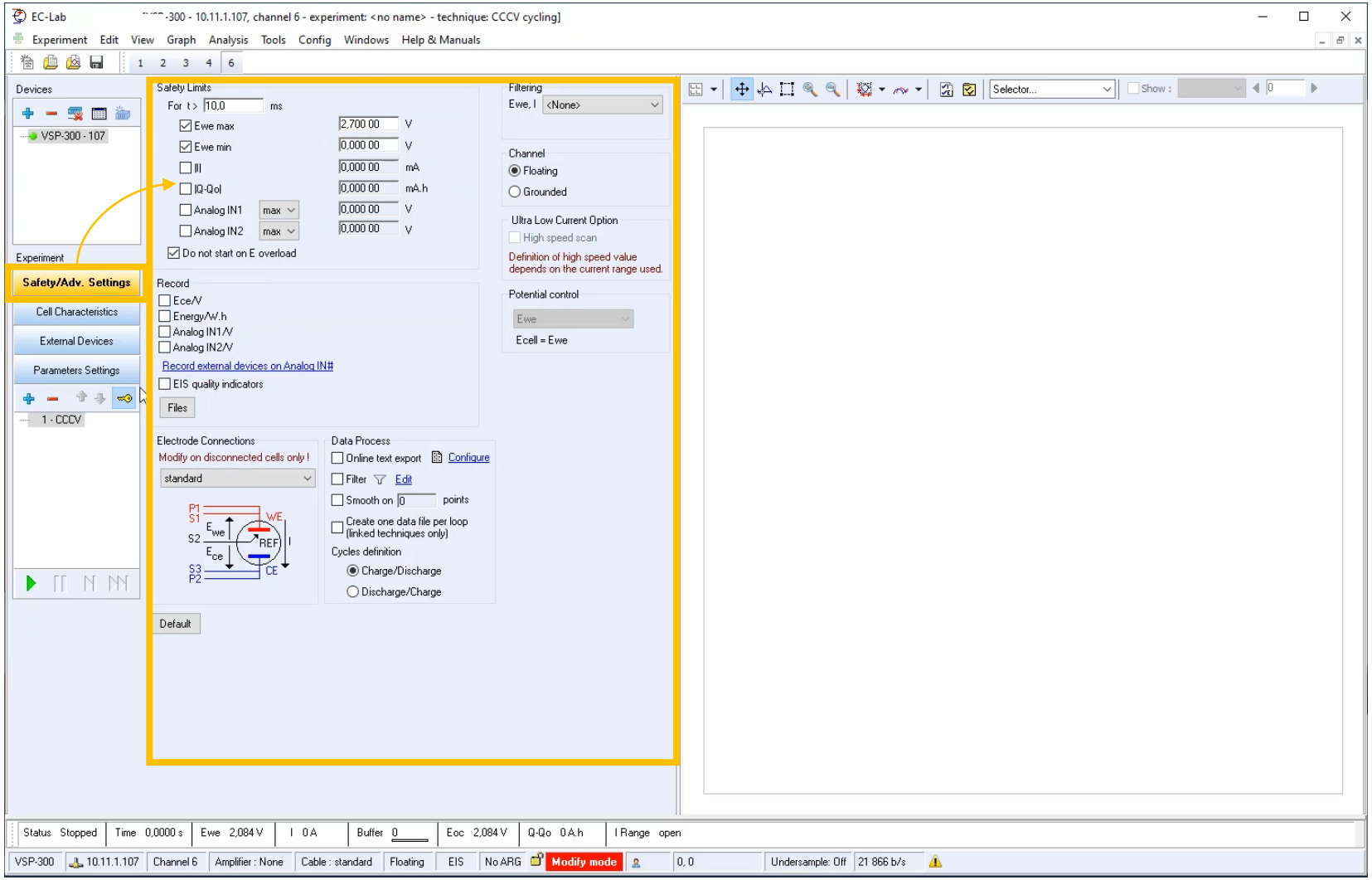
Dedicated battery section

Fill battery capacity to work in C-rate instead in current



Step 4: Set general parameters

- Safety and Advanced Settings are available here

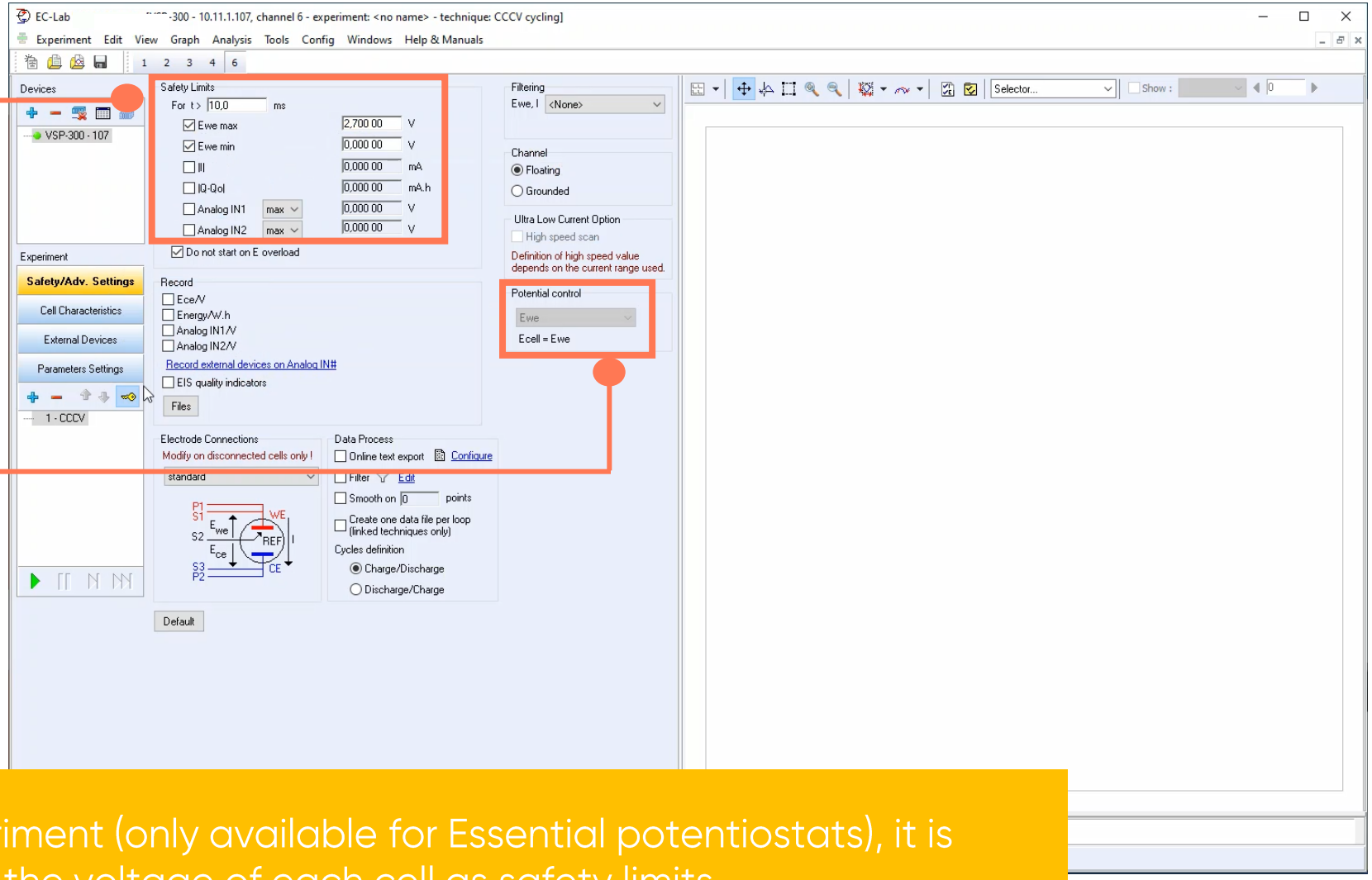


Note: This windows is different for the Essential and Premium instruments.

Step 4: Set general parameters

Safety limits are active for all loaded techniques, if a limit is reached: paused

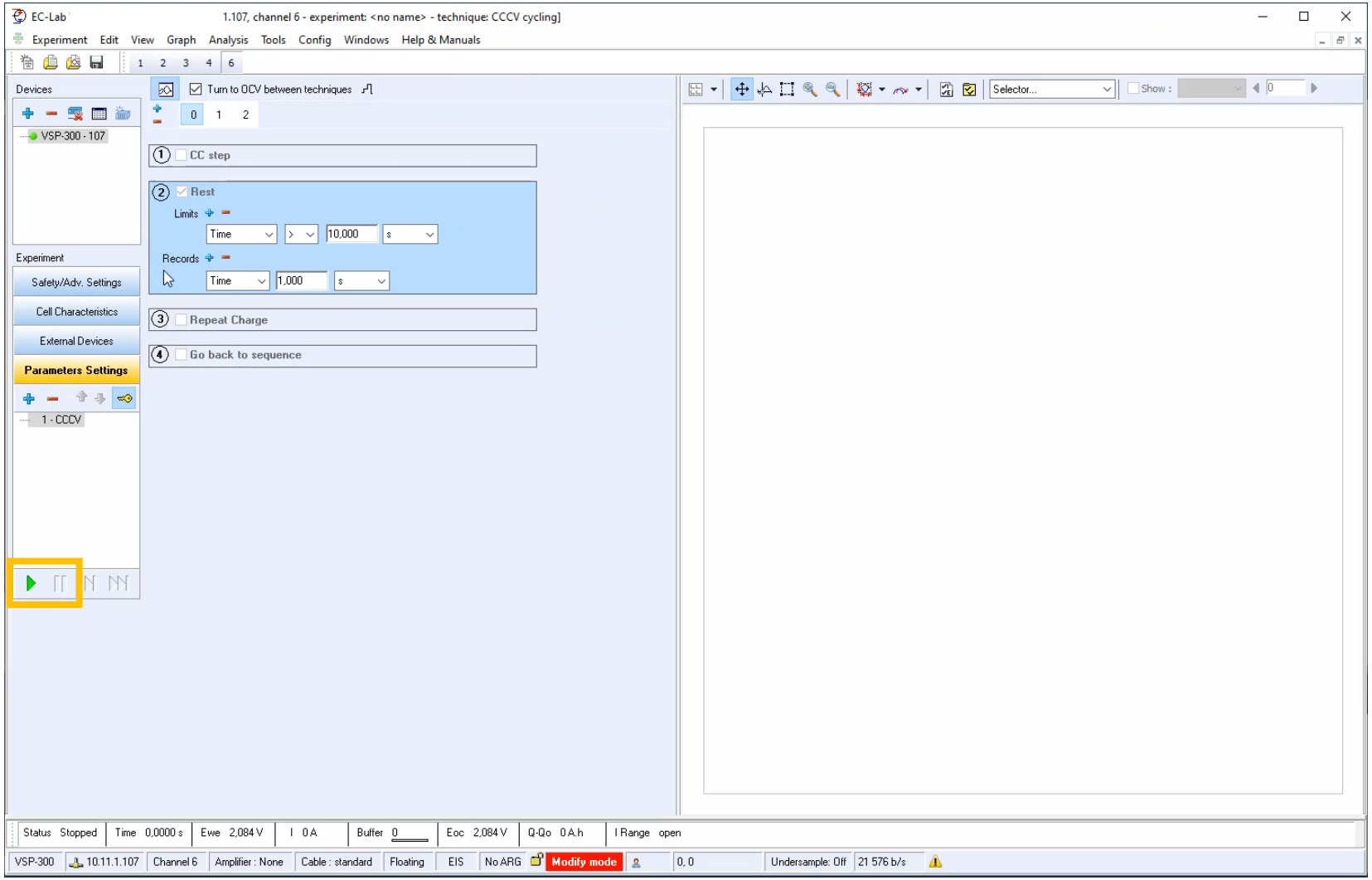
Control potential of Ewe (between positive electrode and ref) or Ewe-Ece (between positive and negative electrode)



For stack experiment (only available for Essential potentiostats), it is possible to use the voltage of each cell as safety limits.

Step 5: Launch the measurement

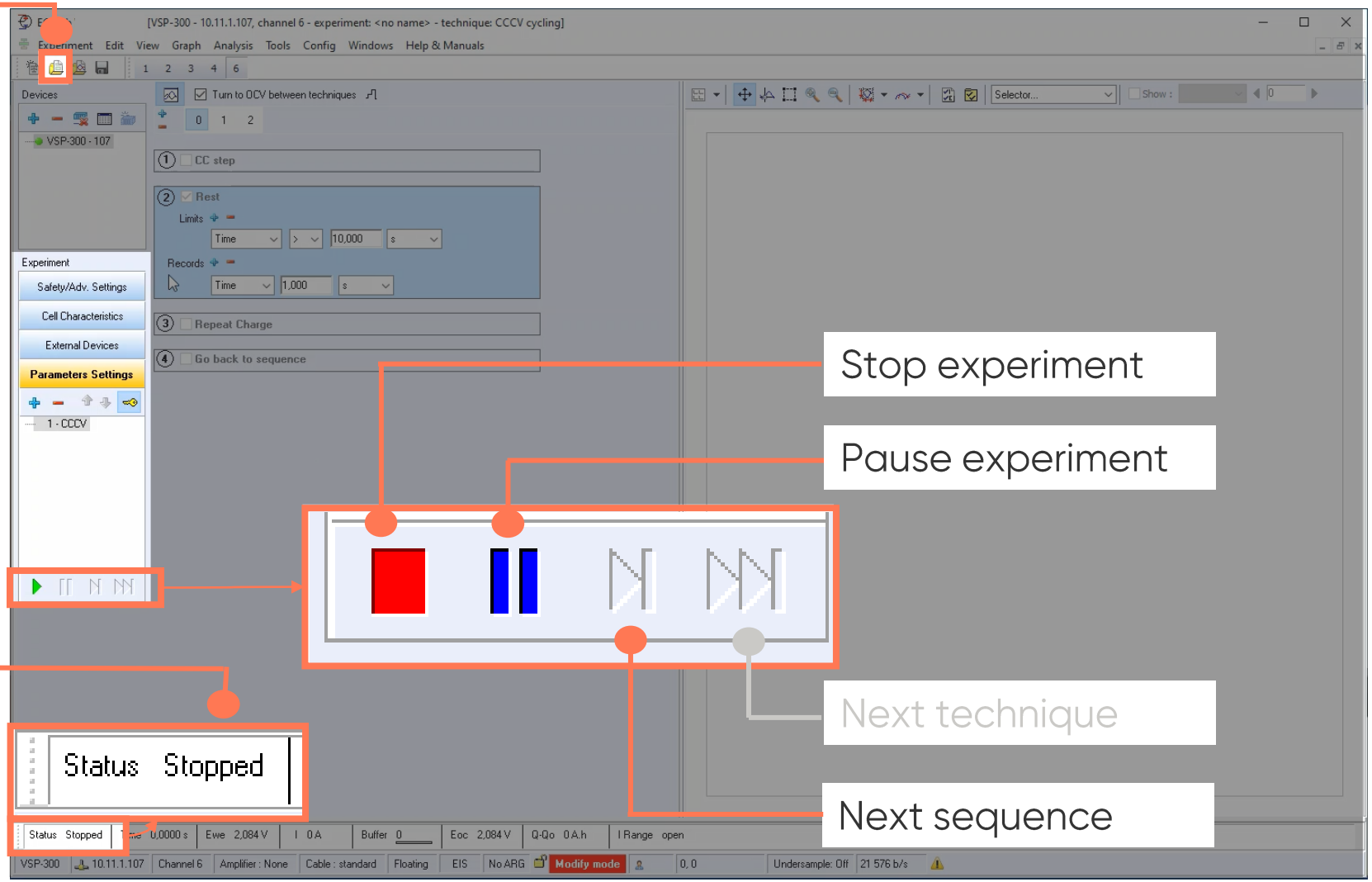
- Click on ▷ to launch experiment



Note: All the settings may be changed during the experiment (Modify on the fly) except Irange, Erange, bandwidth

Step 5: Launch the measurement

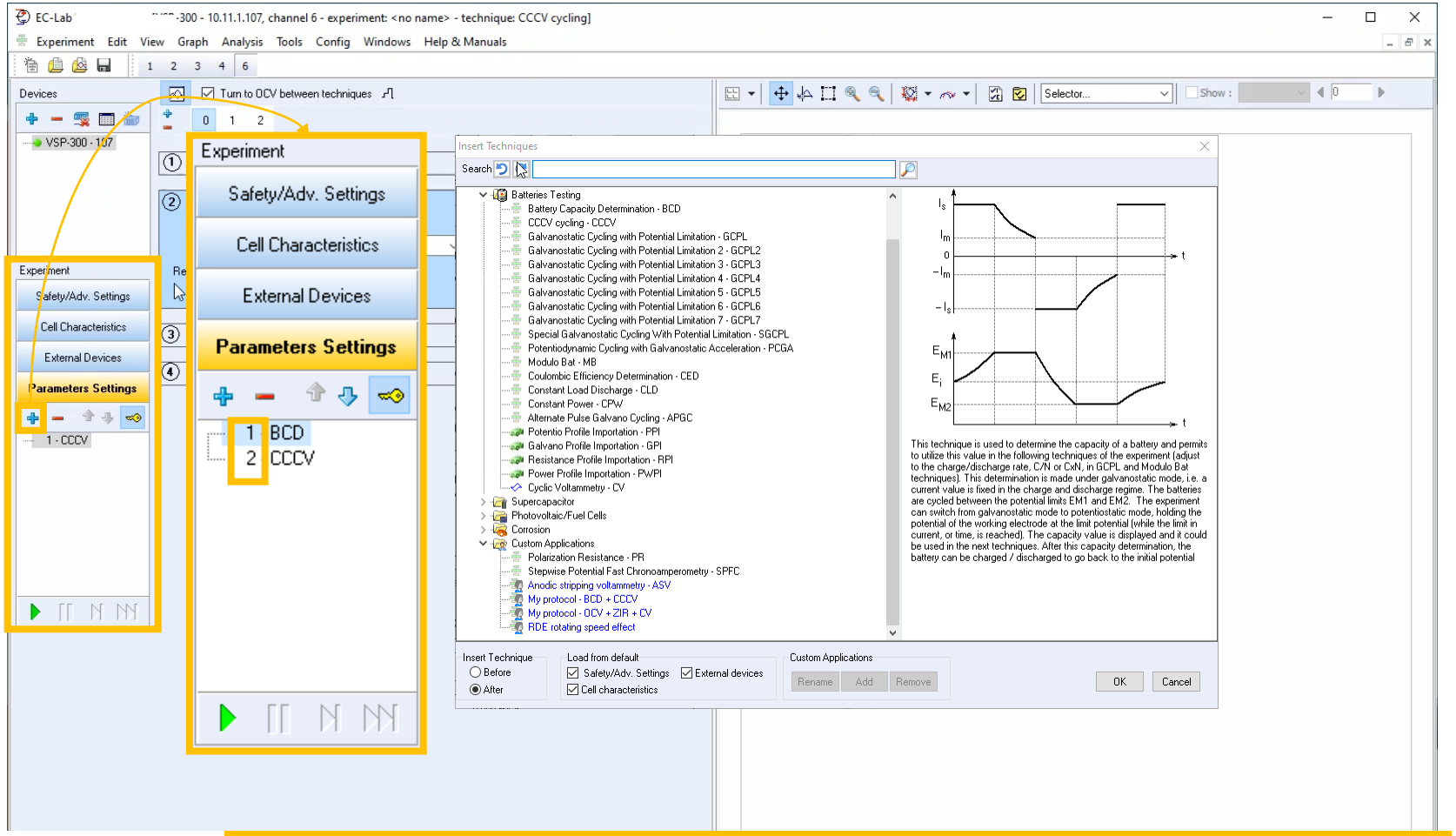
Load techniques with same settings using a .mps file created when launching the experiment



Status of experiment is displayed (Stopped, Paused, Relax...)

Step 6: Add additional experiments

- Click on + button to add more techniques
- Order of execution appears in the technique list

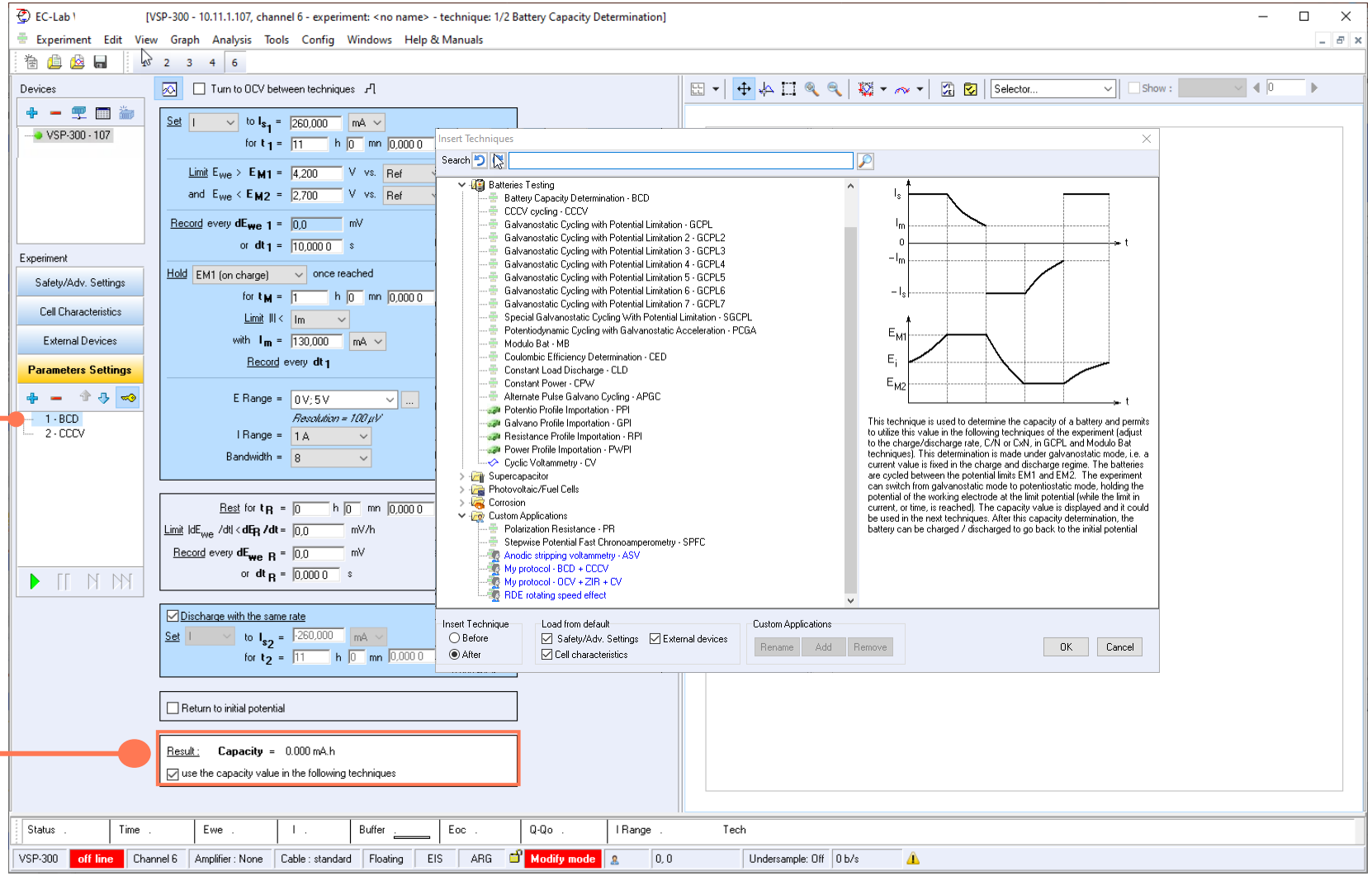


You can save **personalized protocols** to technique list with Save As Custom Application... (in the main bar menu Experiment) and find it under Electrochemical Application - Custom Applications

My protocol - BCD + CCCV

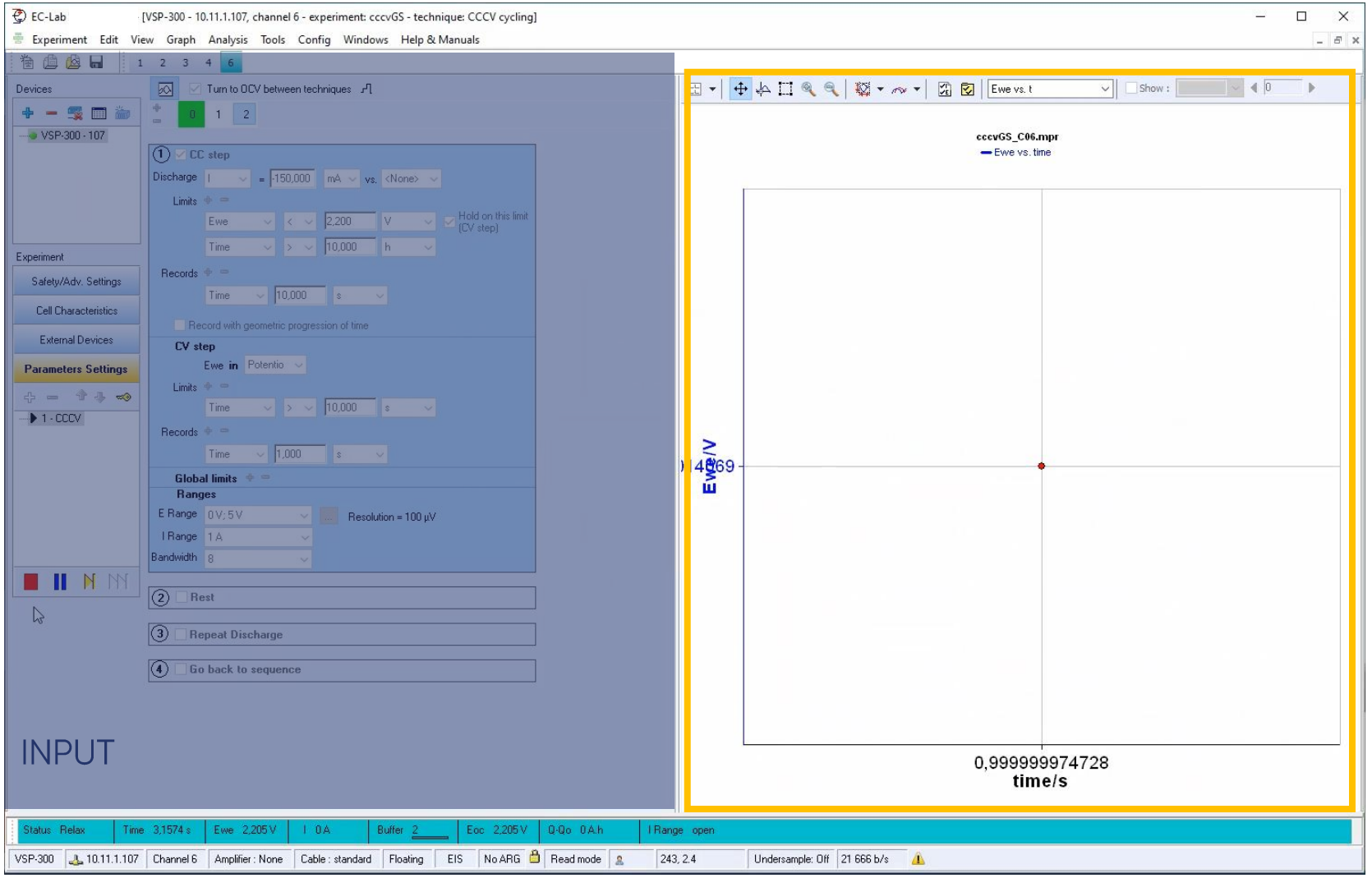
Step 6: Add additional experiments

Can be used to determine battery capacity and use value in the following technique (refer to TN#38)



Step 7: Read the graph

- Graphic is displayed in real time
- Data are saved in .mpr file

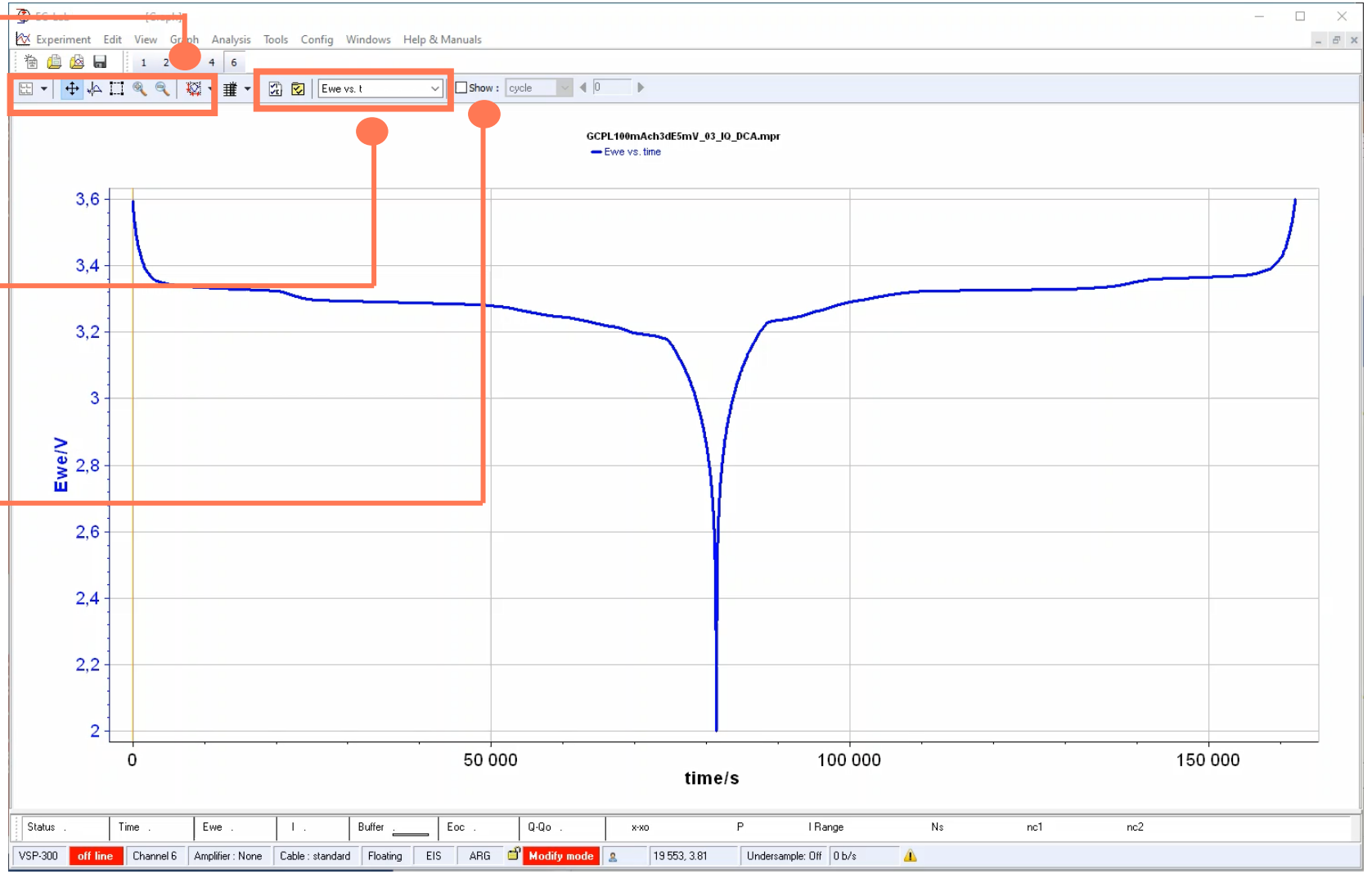


Step 7: Read the graph

Browse though the graph
(Filter, Scroll, Cursor, Selection, Zoom +, Zoom -, Autoscale)

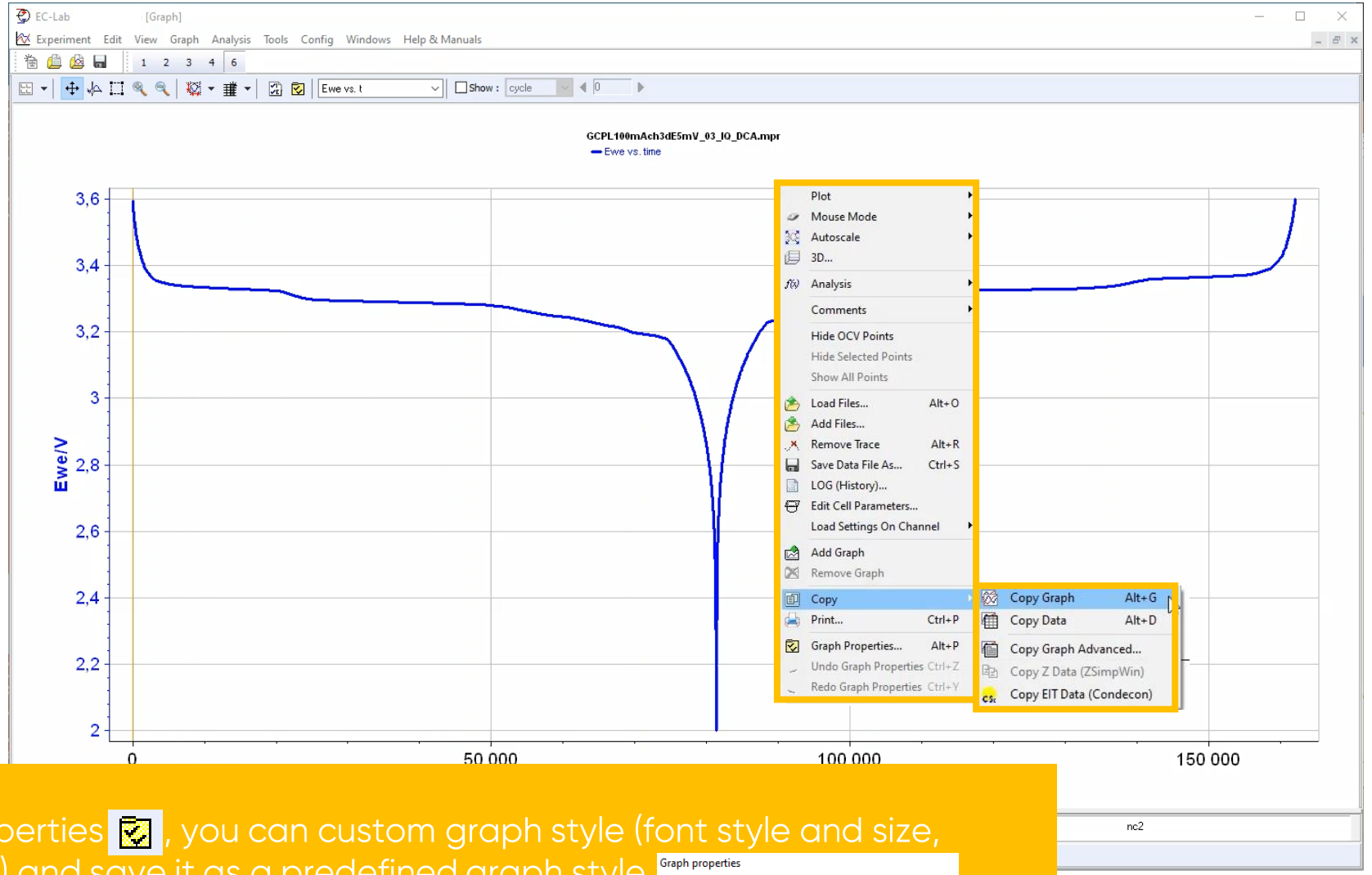
Modify the graph
(Selector, graphic properties, representations)

Show only selected cycle

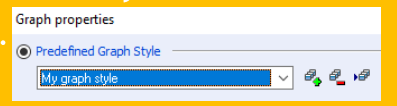


Step 7: Read the graph

- Copy graph as a picture with a right click on the graph

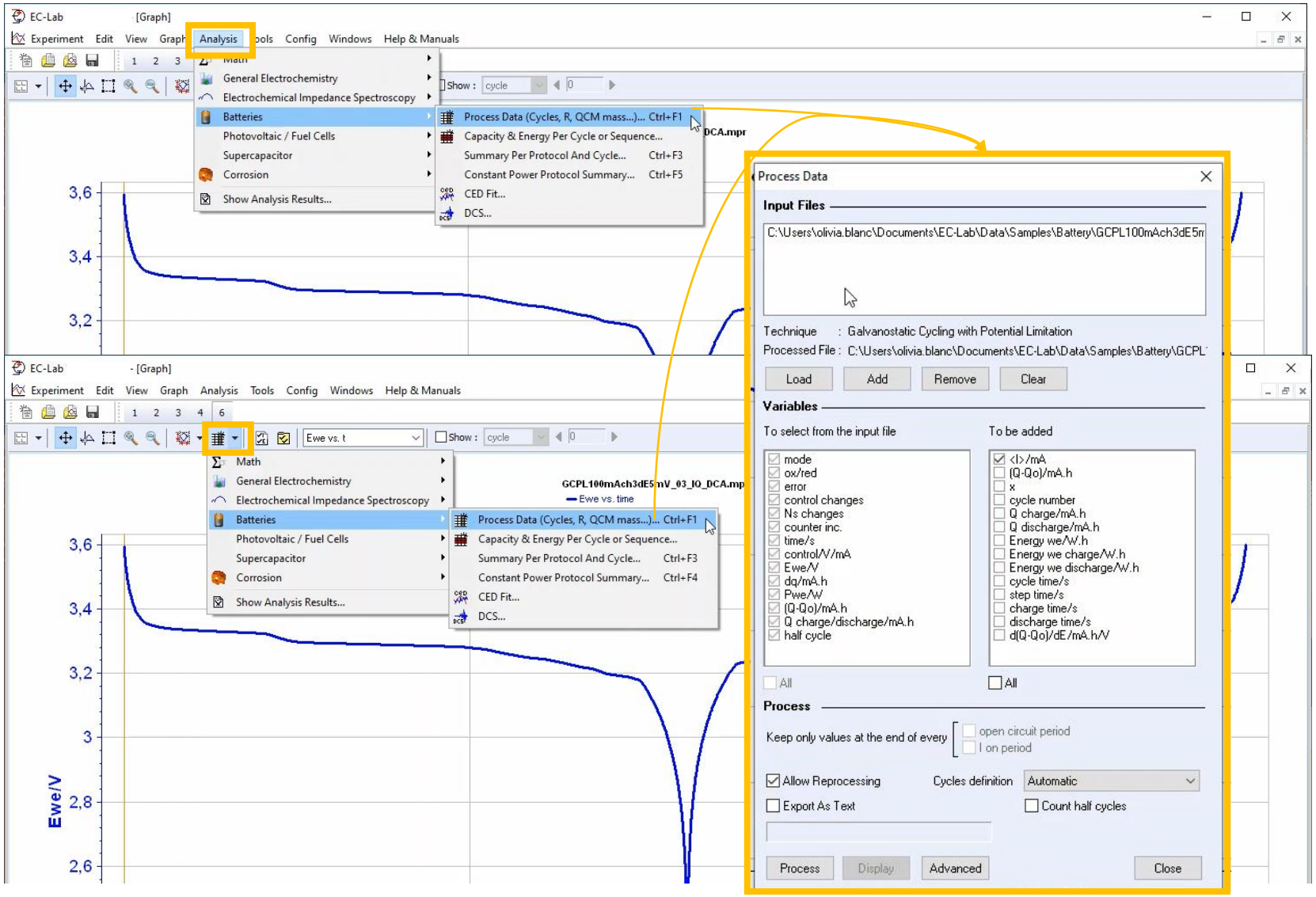


In graph properties , you can custom graph style (font style and size, traces, grid...) and save it as a predefined graph style.



Step 8: Analyse the data with Process Data

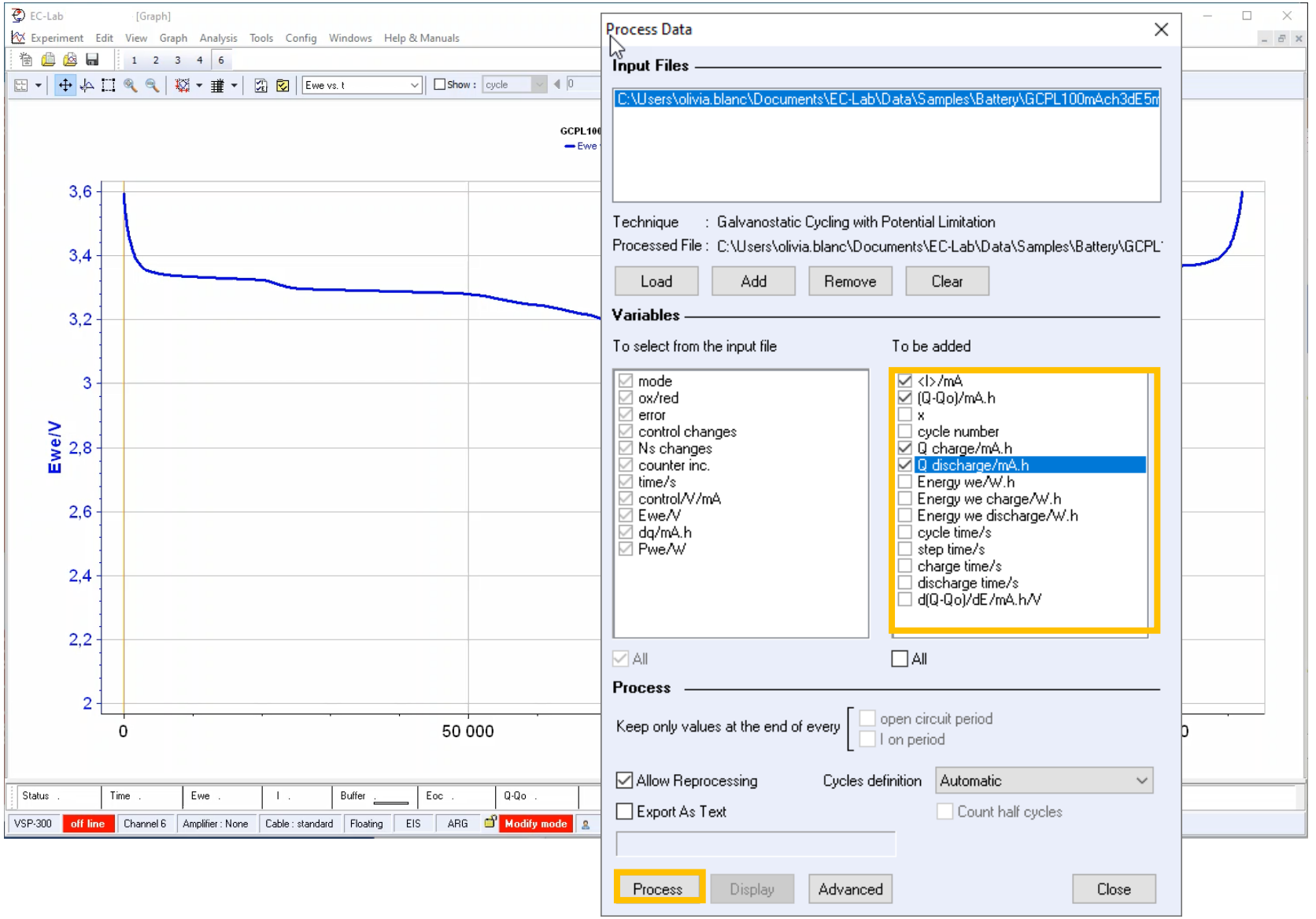
- Analyse with Process Data



Note: Analysis is available either in the main tool bar or as a shorcut in the graph bar, or with F6

Step 8: Analyse the data with Process Data

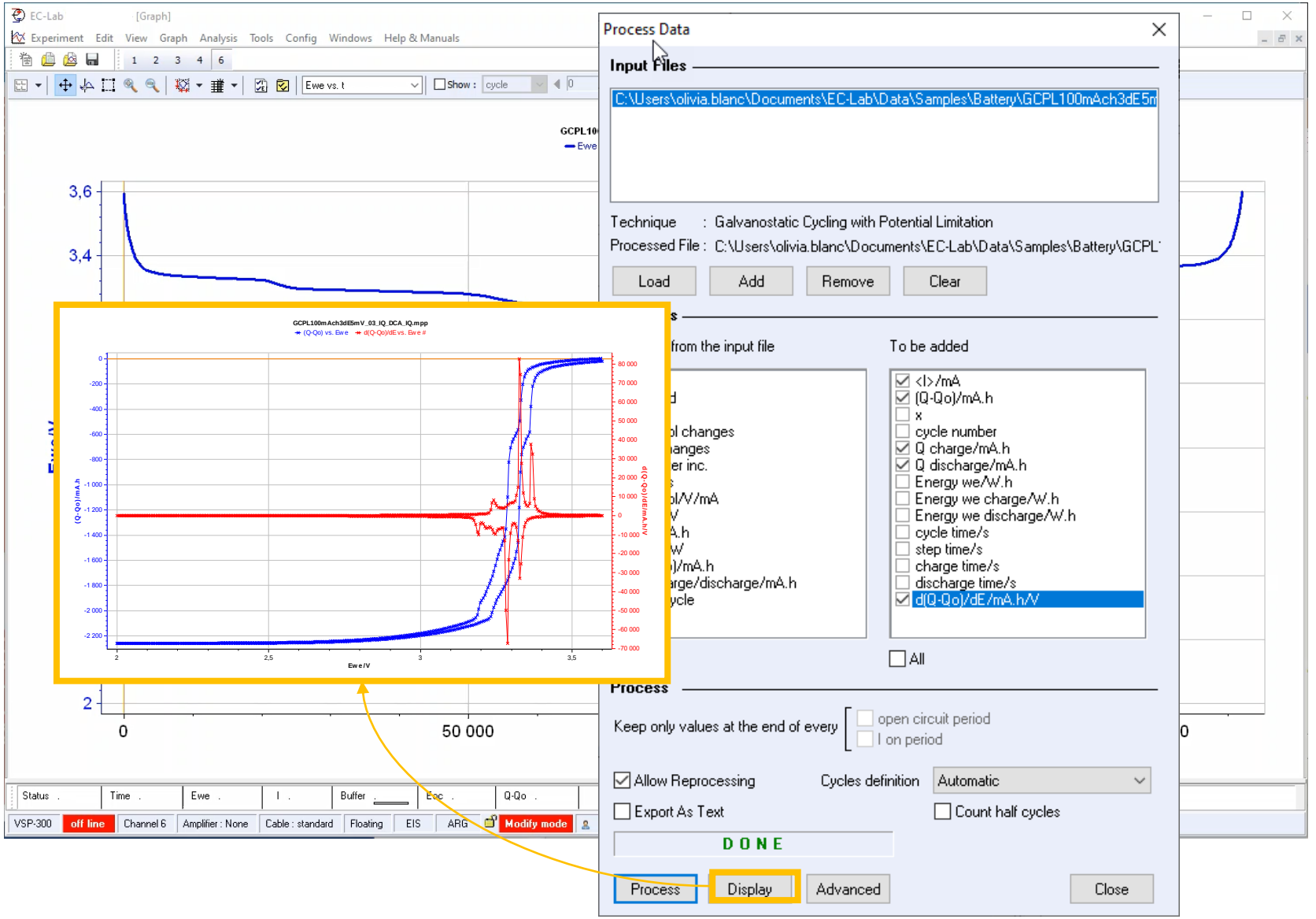
- Select desired variables
- Click on Process



Note: You can export result as text by checking corresponding box

Step 8: Analyse the data with Process Data

- Display the result

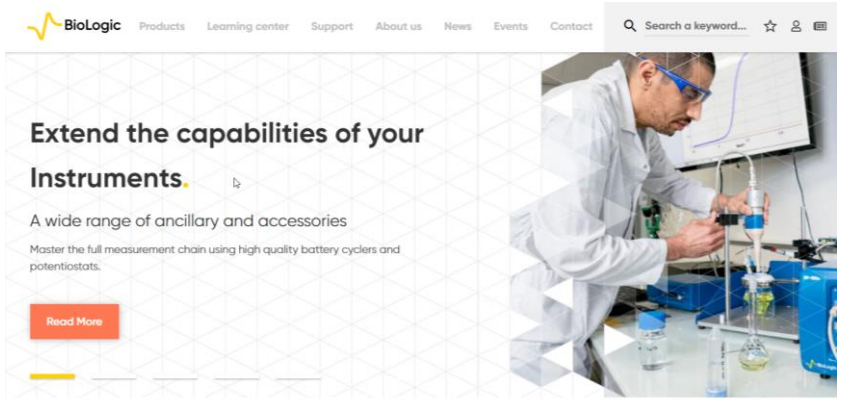


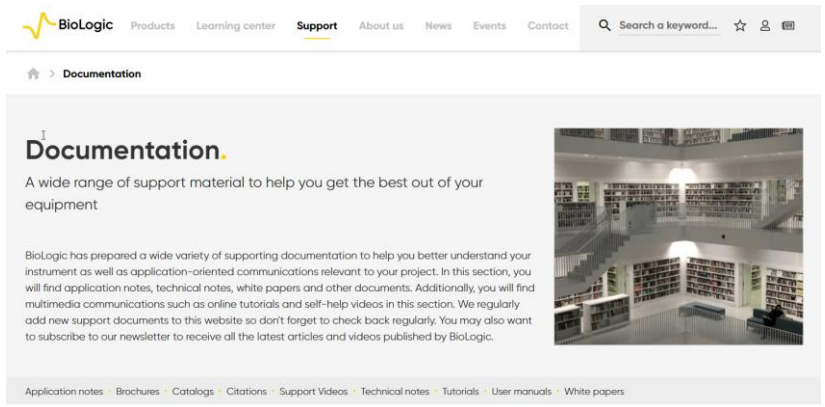
Note: For more detail about differential (or incremental) capacity analysis, refer to AN#40

Find out more

For supplementary information

Visit our website!





www.biologic.net

- Documentation list
  - How to read battery cycling curves (article)
  - How to obtain battery cycling data of interest? (video)
  - Data of interest – work more efficiently (article)
  - EC-Lab Techniques and Applications (manual)
  - EC-Lab Analysis and Data Process (manual)

Did you know? **Free update of EC-Lab®** are available on our website.

Need help?

Contact us!

Contact - BioLogic

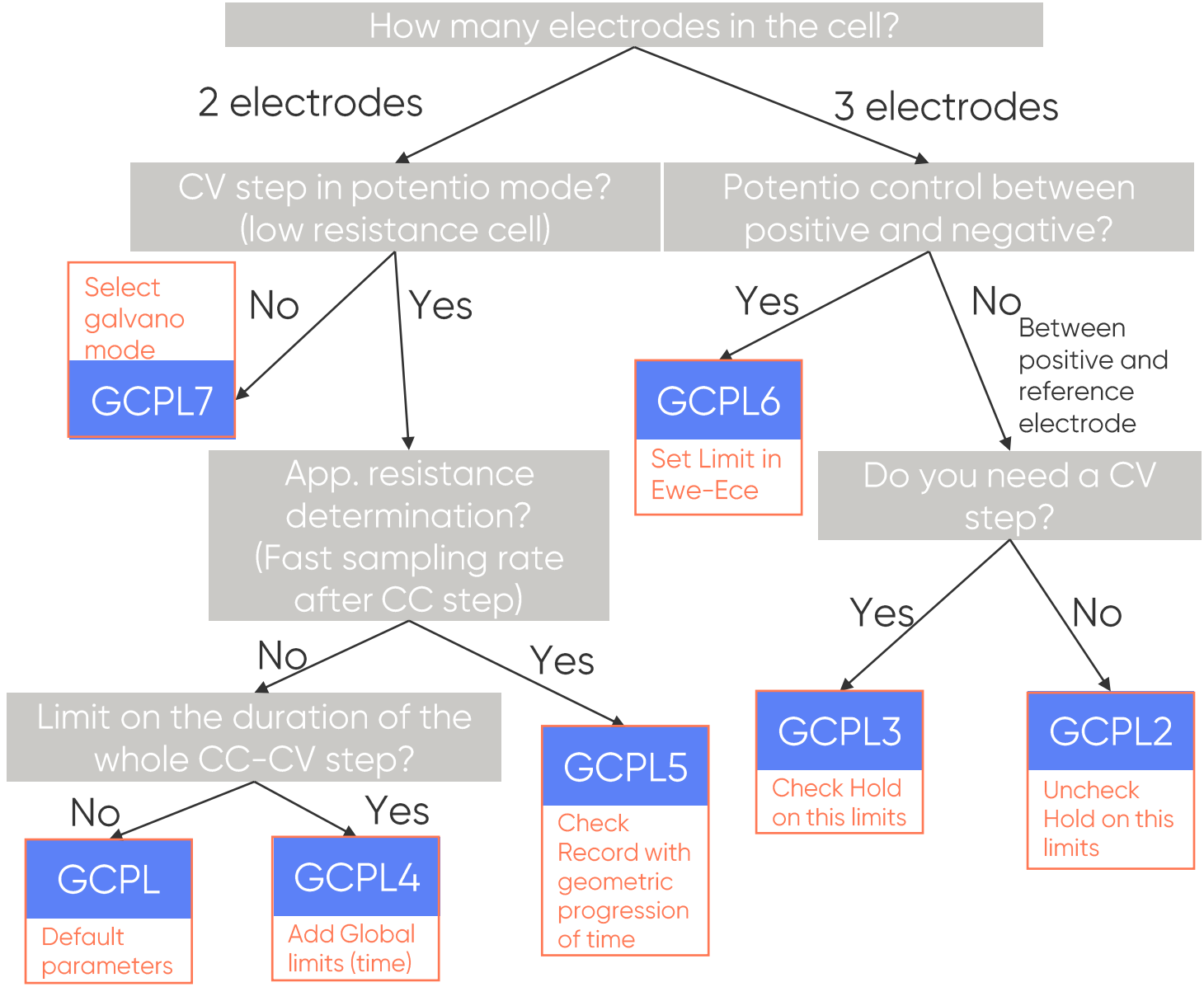
- Helpful information to provide when contacting support center:
  - Serial number of the instrument (located on the rear panel of the device)
  - Software and hardware version you are currently using (on the Help menu, About on EC-Lab)
  - Operating system on the connected computer
  - Connection mode (Ethernet, LAN, USB) between computer and instrument

FAQ

- What is the difference between CCCV and GCPL?
- What is the difference between compliance and control voltage?
- How do I connect potentiostat to the cell?
- How to manage temperature measurement/control during electrochemical investigations?

What is the difference between CCCV and GCPL ?

- CCCV technique covers all GCPL techniques thanks to modular control and limit options
- Switch easily from GCPL to CCCV with this diagram



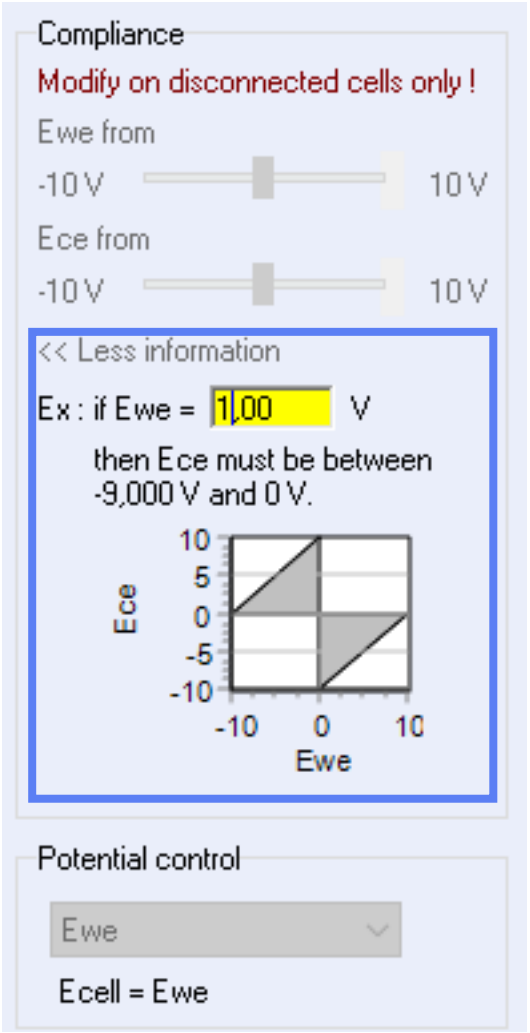
What is the difference between compliance and control voltage?

- Compliance is the voltage between WE and CE
- Control voltage is the voltage between WE and RE

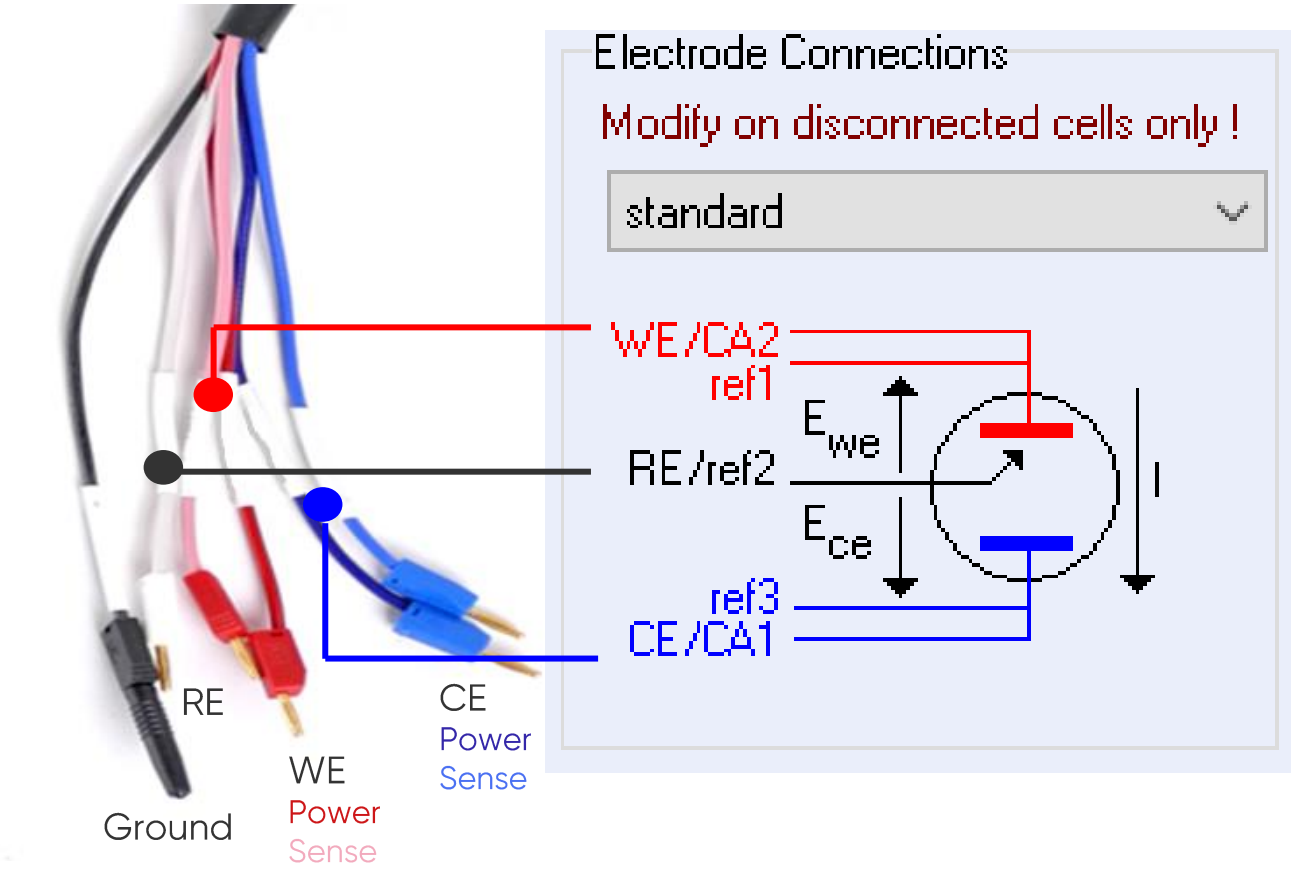
- Verify the desired voltage to apply matches with the compliance.
  - For Premium: compliance = ±12 V
  - For Essential: compliance = 20 V adjustable from ±10 V, between [-20 ; 20] V

For a single cell, the voltages of a battery are included in the range of [2; 5 V] so the standard compliance of -10 to 10 V will be ok. For a battery stack, this may be adjusted from 0 to 20V to allow measurements up to 20 V.

NB : Compliance is adjustable only on essential instrument in Safety/Adv Settings.



How do I connect potentiostat to the cell?



- In standard electrode connections mode:
  - Working Electrode (WE)

  Connect power and sense

  - Reference Electrode (RE)

  To connect for a 2 electrode system

  - Counter Electrode (CE)

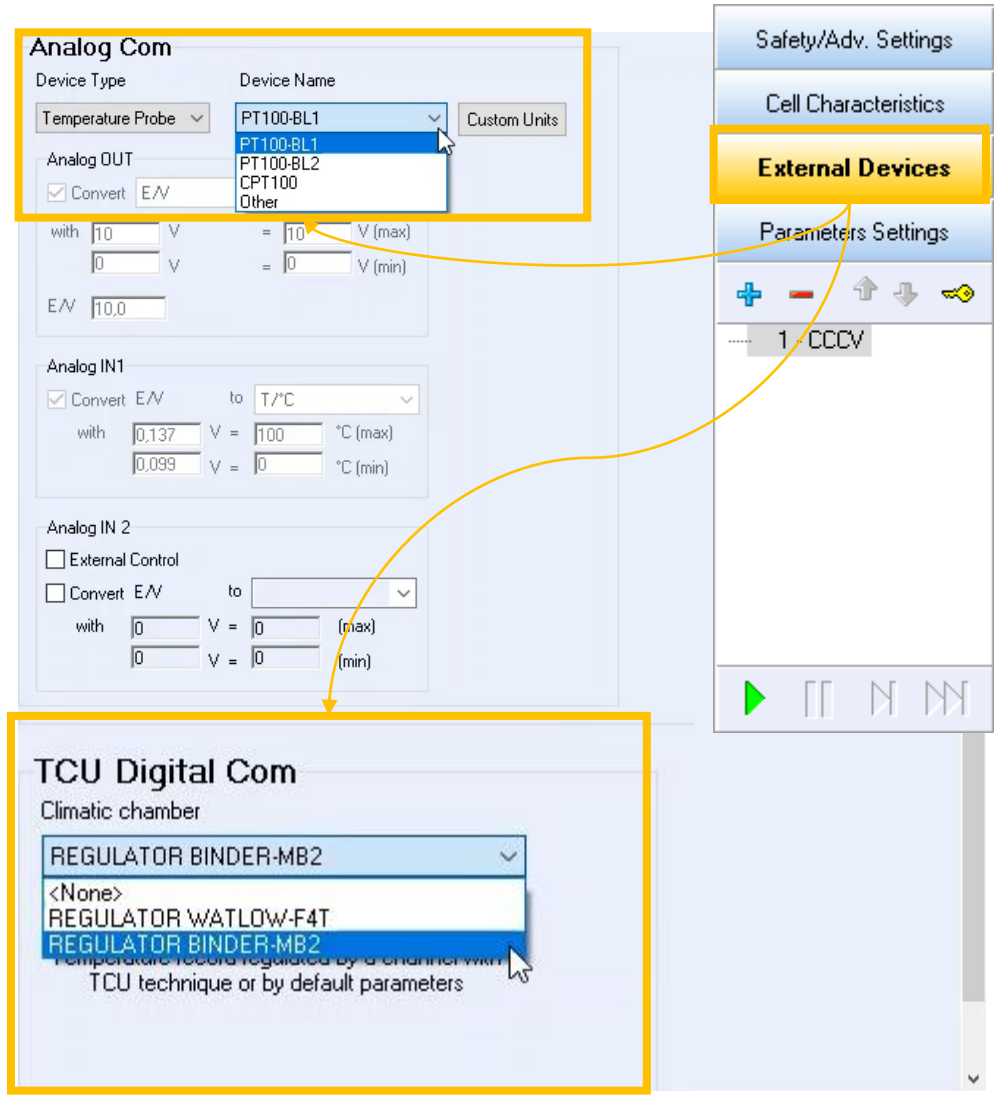
  Connect power and sense

Note: For other connection modes, refer to Connection to the cell (article) or Technical Notes #09 and #11, or Installation and Configuration Manual.

How to manage temperature measurement/control during electrochemical investigations?

- Monitor temperature by coupling a temperature probe with Analog Com
  Note: Refer to TN#36

- Control the regulator of a climatic chamber with TCU Digital Com and TCU technique
  Note: Refer to Installation and Configuration Manual of the TCU Server and related videos



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