



Getting Started with EC-Lab<sup>®</sup>:

# Constant Current Constant Voltage

V1

Getting Started EC-Lab: CCCV

March 2024



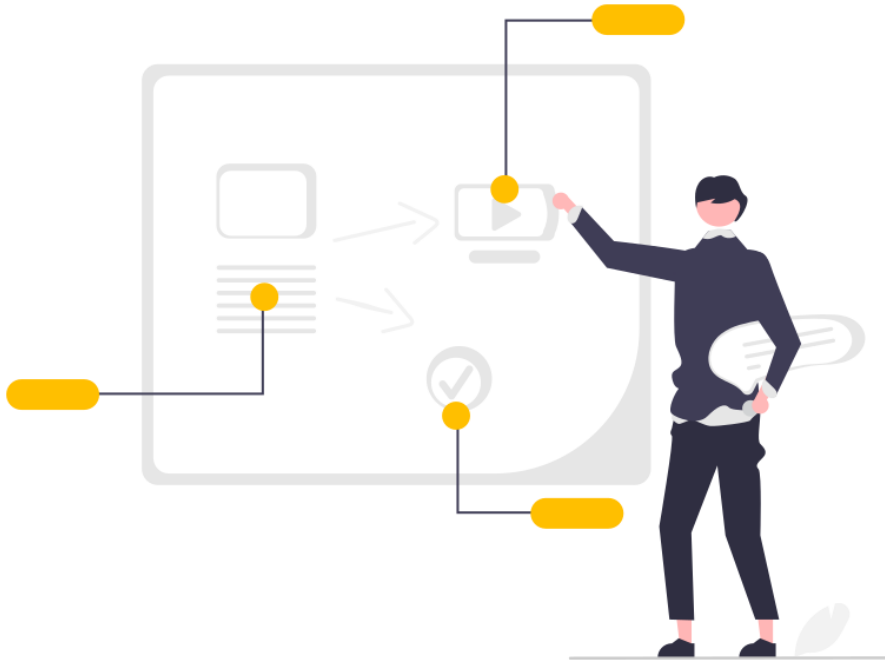
# Overview and quick access

## ■ Procedure

- Launch the experiment
  - [Step 0](#): Connect instrument and select channel
  - [Step 1](#): Add CCCV technique
  - [Step 2](#): Set CCCV parameters
  - [Step 3](#): Optimize the measurement
  - [Step 4](#): Set general parameters
  - [Step 5](#): Launch the measurement
  - [Step 6](#): Add additional experiments
- Investigate the result
  - [Step 7](#): Read the graph
  - [Step 8](#): Analyse the data with Process Data

## ■ Find out more

- [For supplementary information](#)
- [Need help?](#)
- [FAQ](#)

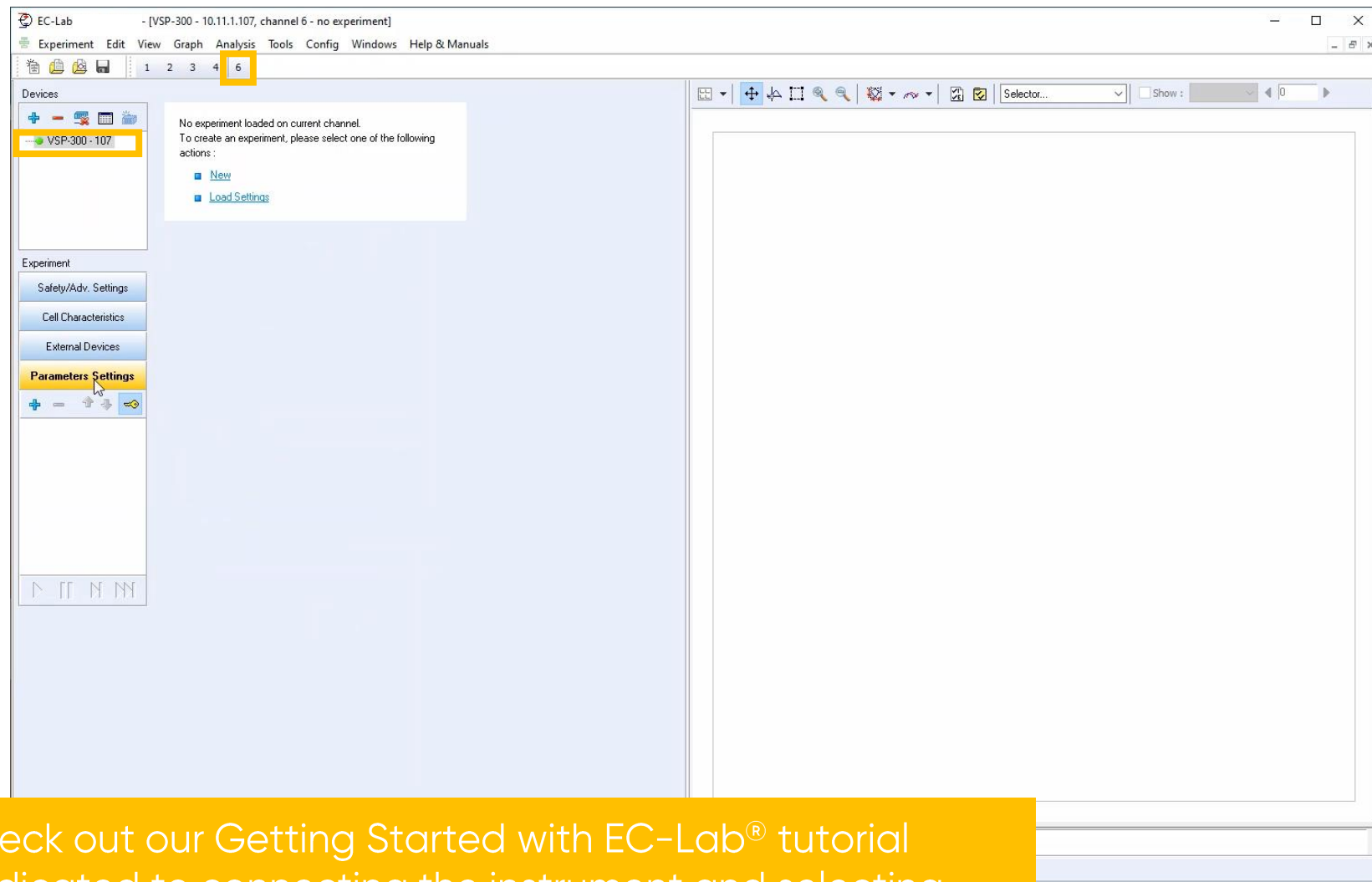


# Procedure



# Step 0: Connect instrument and select channel

- Connect instrument and select channel

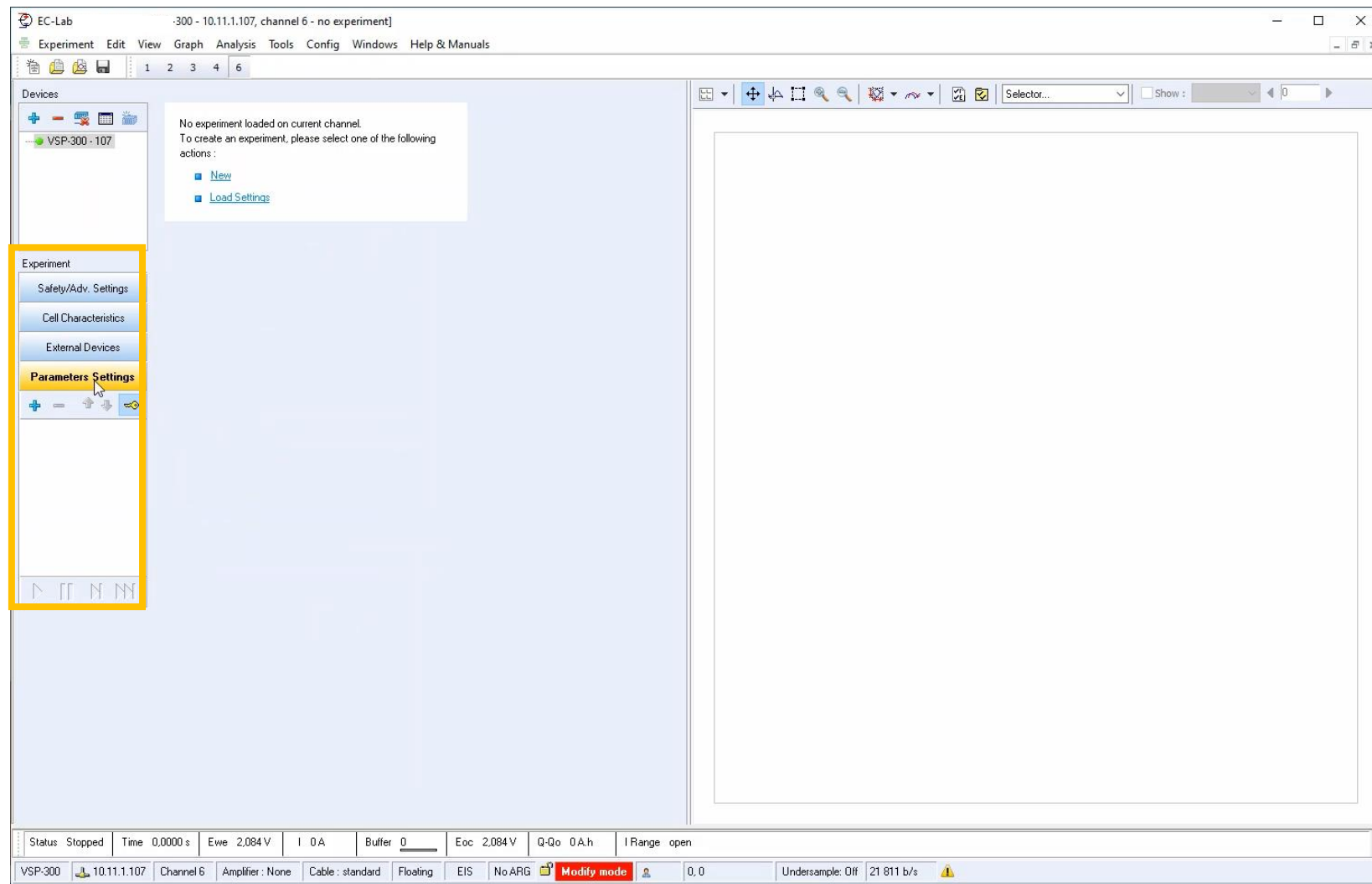


Check out our Getting Started with EC-Lab® tutorial dedicated to connecting the instrument and selecting channels.



# Step 0: Connect instrument and select channel

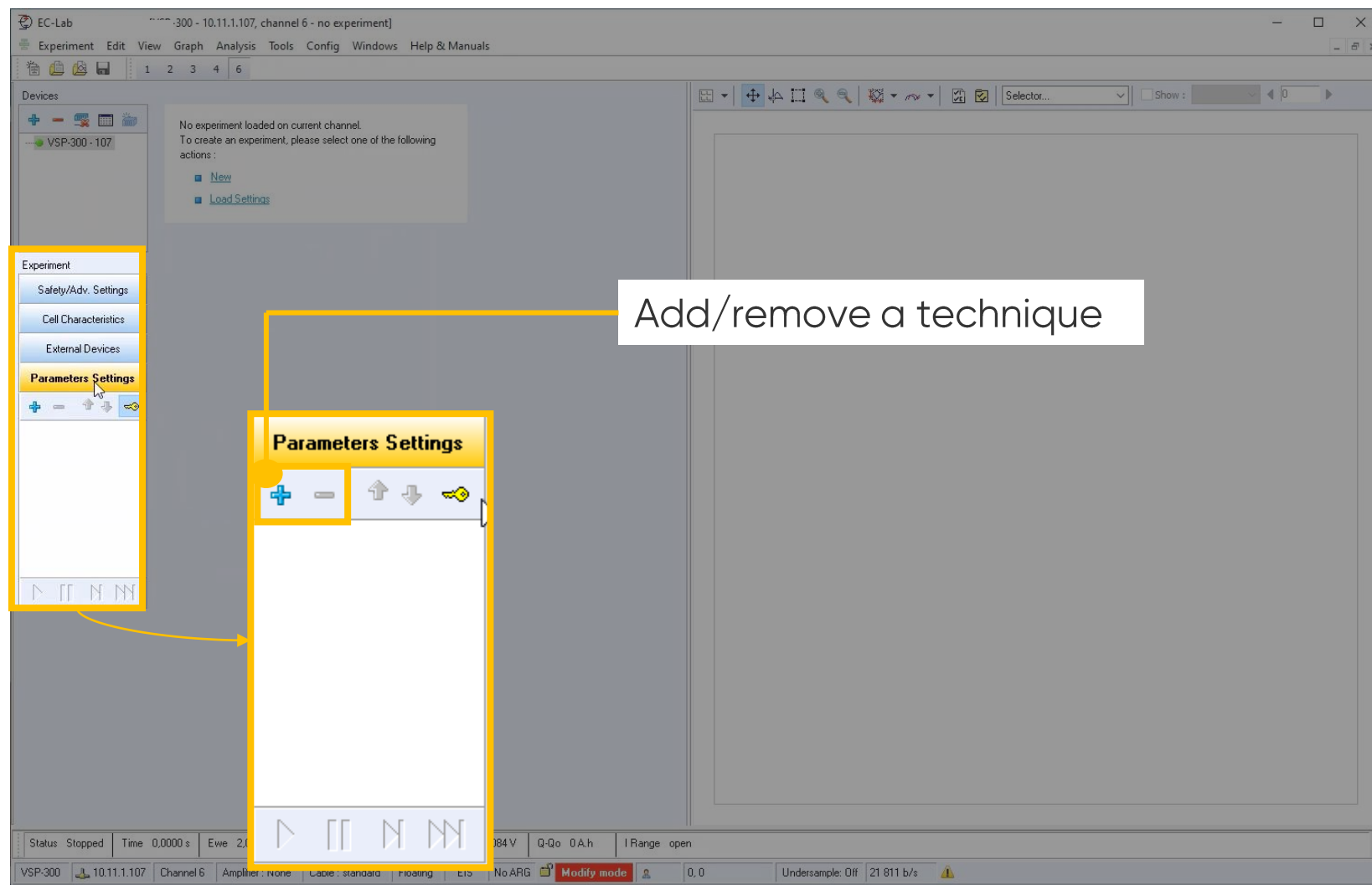
- When the instrument and channel are selected, the user can set the experiment





# Step 1: Add CCCV technique

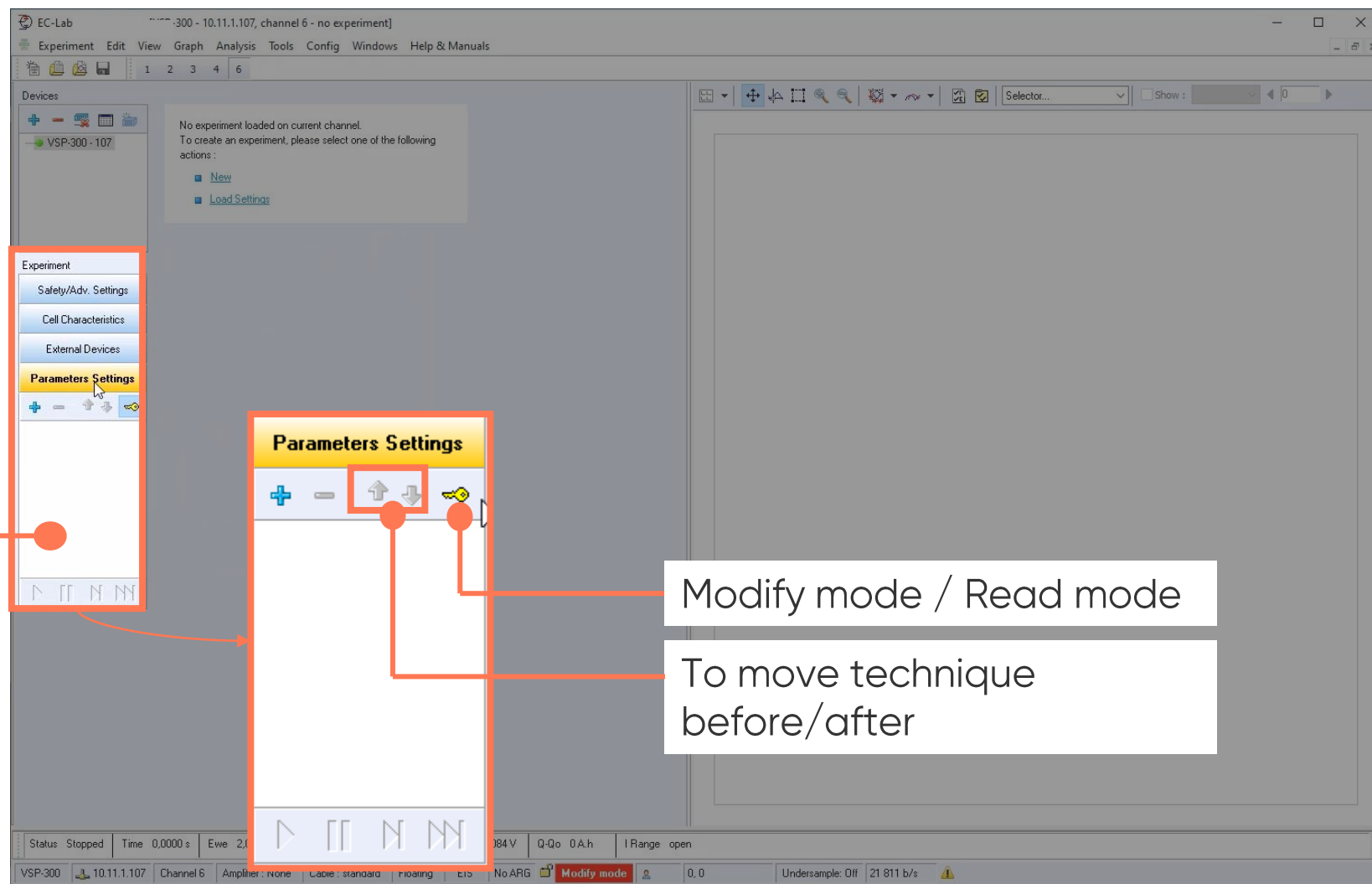
- Click on + to add a technique in the list





# Step 1: Add CCCV technique

Empty window:  
no technique loaded



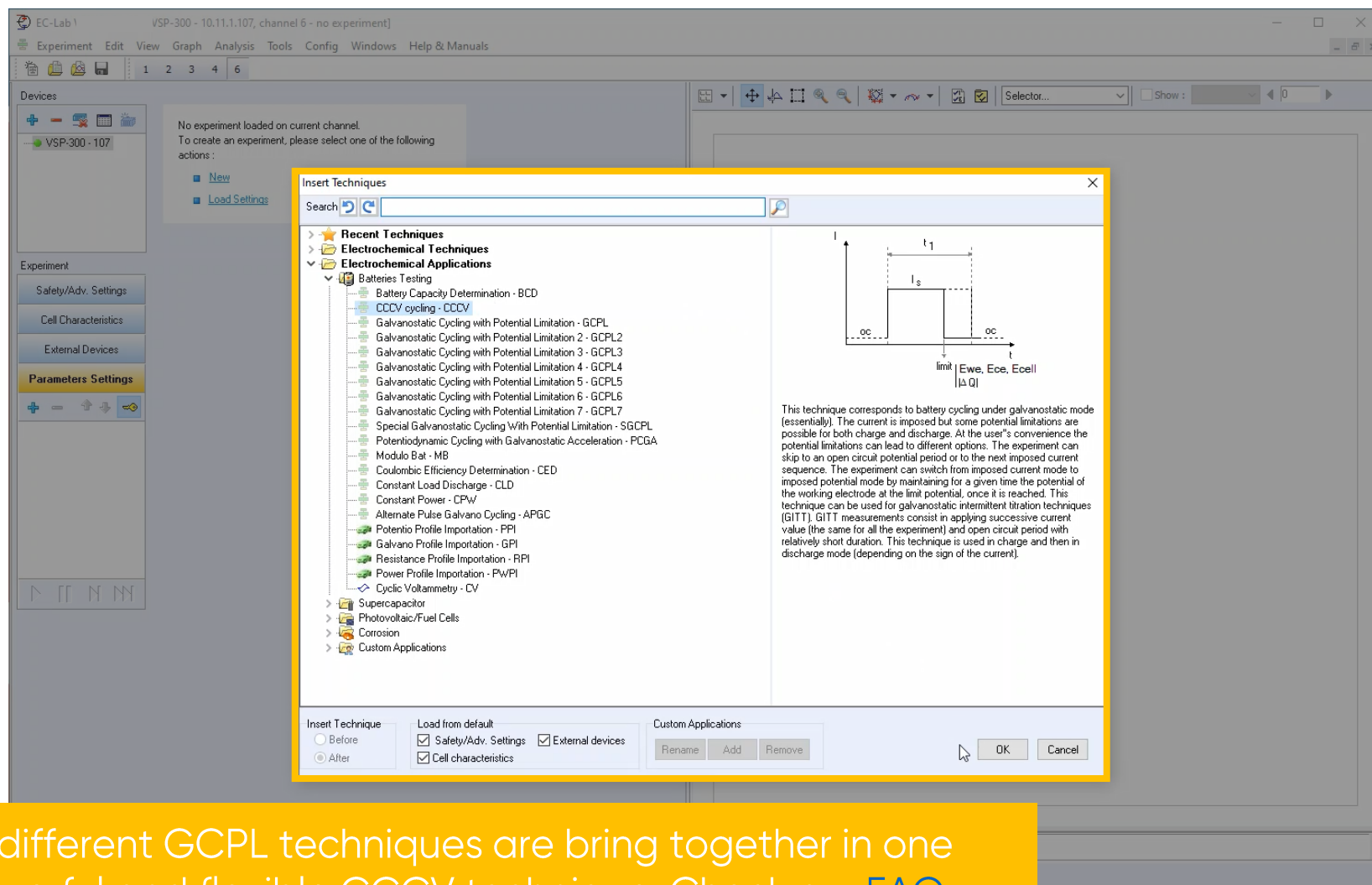
Modify mode / Read mode

To move technique  
before/after



# 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 brought 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

EC-Lab 1 VSP-300 - 10.11.1.107, channel 6 - no experiment]

Experiment Edit View Graph Analysis Tools Config Windows Help & Manuals

1 2 3 4 6

Devices

+ - [Icons]

VSP-300 - 107

No experiment loaded on current channel.  
To create an experiment, please select one of the following actions :

New Load Settings

Experiment

Safety/Adv. Settings

Cell Characteristics

External Devices

Parameters Settings

Insert Techniques

Search [Search Bar]

Recent Techniques

Electrochemical Techniques

Batteries Testing

- Battery Capacity Determination - BCD
- CCCV cycling - CCCV
- Galvanostatic Cycling with Potential Limitation - GCPL
- Galvanostatic Cycling with Potential Limitation 2 - GCPL2
- Galvanostatic Cycling with Potential Limitation 3 - GCPL3
- Galvanostatic Cycling with Potential Limitation 4 - GCPL4
- Galvanostatic Cycling with Potential Limitation 5 - GCPL5
- Galvanostatic Cycling with Potential Limitation 6 - GCPL6
- Galvanostatic Cycling with Potential Limitation 7 - GCPL7
- Special Galvanostatic Cycling With Potential Limitation - SGCP
- Potentiodynamic Cycling with Galvanostatic Acceleration - PCGA
- Modulo Bat - MB
- Coulombic Efficiency Determination - CED
- Constant Load Discharge - CLD
- Constant Power - CPW
- Alternate Pulse Galvano Cycling - APGC
- Potential Profile Importation - PPI
- Galvano Profile Importation - GPI
- Resistance Profile Importation - RPI
- Power Profile Importation - PWPI
- Cyclic Voltammetry - CV

Supercapacitor

Photovoltaic/Fuel Cells

Corrosion

Custom Applications

Insert Technique

Before After

Load from default

Safety/Adv. Settings External devices

Cell characteristics

Custom Applications

Rename Add Remove

OK Cancel

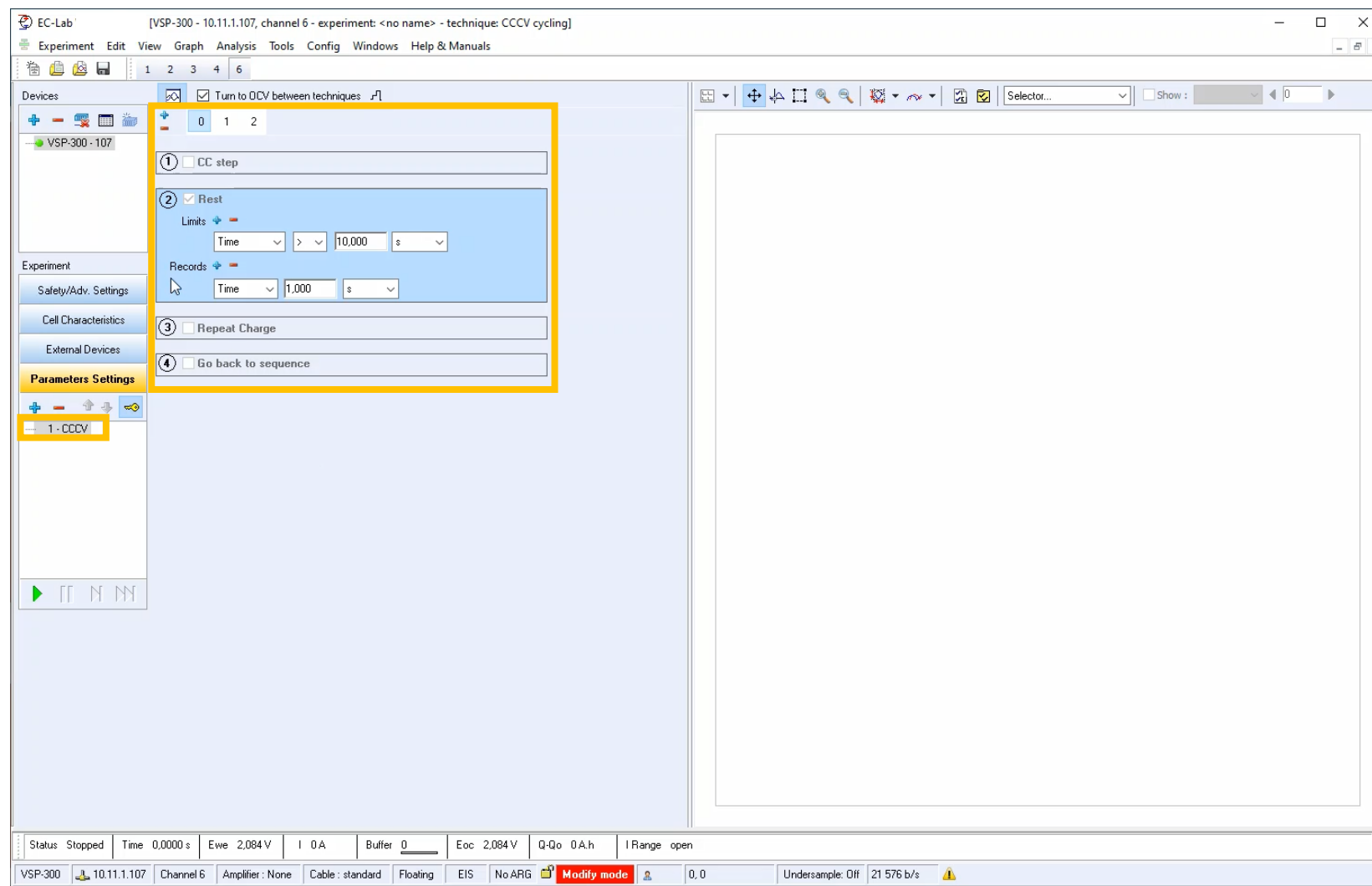
Status Stopped Time 0,0000 s Ewe 2,084 V I 0 A Buffer 0 Eoc 2,084 V Q-Qo 0 A.h I Range open

VSP-300 10.11.1.107 Channel 6 Amplifier : None Cable : standard Floating EIS No ARG Modify mode 0,0 Undersample: Off 21 630 b/s



# 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

The screenshot displays the EC-Lab software interface for configuring a CCCV (Constant Current Constant Voltage) experiment. The main workspace shows three steps in the sequence:

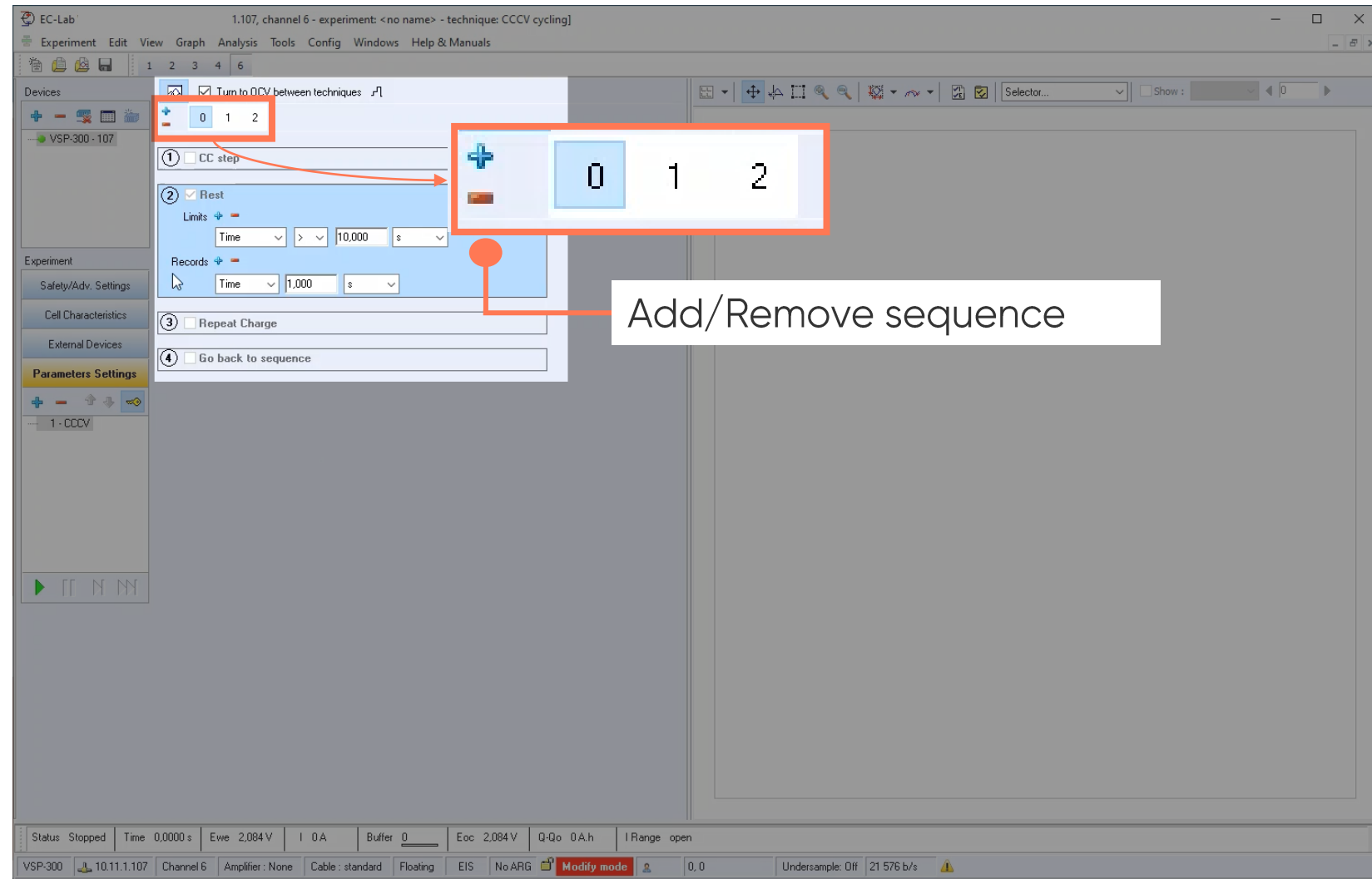
- Step 1: Rest** (highlighted in orange):
  - Charge: 150,000 mA vs. <None>
  - Limits: Ewe > 2,500 V, Hold on this limit (CV step)
  - Records: Time 1,000 s
  - CV step: Ewe in Potentio
  - Limits: Time > 10,000 s
  - Global limits: E Range 0V; 5V, I Range 1 A, Bandwidth 8, Resolution = 100  $\mu$ V
- Step 2: Charge** (highlighted in orange):
  - Discharge: -150,000 mA vs. <None>
  - Limits: Ewe < 2,200 V, Hold on this limit (CV step)
  - Records: Time 10,000 s
  - CV step: Ewe in Potentio
  - Limits: Time > 10,000 s
  - Global limits: E Range 0V; 5V, I Range 1 A, Bandwidth 8, Resolution = 100  $\mu$ V
- Step 3: Discharge** (highlighted in orange):
  - Rest: (No parameters shown)
  - Repeat Discharge: (No parameters shown)
  - Go back to sequence: (No parameters shown)

The status bar at the bottom indicates the experiment is stopped, with various measurement values like Time 0.0000 s, Ewe 2.084 V, I 0 A, and Buffer 0.



## Step 2: Set CCCV parameters

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





## Step 2: Set CCCV parameters

- Sequence 0 is a rest period

EC-Lab 1.107, channel 6 - experiment: <no name> - technique: CCCV cycling

Experiment Edit View Graph Analysis Tools Config Windows Help & Manuals

Devices VSP-300-107

Experiment Safety/Adv. Settings Cell Characteristics External Devices Parameters Settings

1 - CCCV

1 ☐ CC step

2 ☒ Rest

Limits

Records

3 ☐ Repeat Charge

4 ☐ Go back to sequence

1 ☐ CC step

2 ☒ Rest

Limits

Records

3 ☐ Repeat Charge

4 ☐ Go back to sequence

Status: Stopped Time: 0.0000 s Ewe: 2.084 V I: 0 A Buffer: 0 Eoc: 2.084 V Q-Qo: 0 A.h I Range: open

VSP-300 10.11.1.107 Channel 6 Amplifier: None Cable: standard Floating EIS No ARG Modify mode 0, 0 Undersample: Off 21 576 b/s

Note: Sequence 0 can't be removed



# Step 2: Set CCCV parameters

EC-Lab 1.107, channel 6 - experiment: <no name> - technique: CCCV cycling

Experiment Edit View Graph Analysis Tools Config Windows Help & Manuals

1 2 3 4 6

Devices

- VSP-300-107

Experiment

- Safety/Adv. Settings
- Cell Characteristics
- External Devices
- Parameters Settings**

1 - CCCV

1 ☐ CC step

2 ☒ Rest

Limits  Time  >  10,000 s

Records  Time  1,000 s

3 ☐ Repeat Charge

4 ☐ Go back to sequence

1 ☐ CC step

2 ☒ Rest

Limits  Time  >  10,000 s

Records  Time  1,000 s

3 ☐ Repeat Charge

4 ☐ Go back to sequence

Status Stopped Time 0.0000 s Ewe 2.084 V I 0 A Buffer 0 Eoc 2.084 V Q-Qo 0 A.h I Range open

VSP-300 10.11.1.107 Channel 6 Amplifier : None Cable : standard Floating EIS No ARG Modify mode 0,0 Undersample: Off 21 576 b/s

Non active block

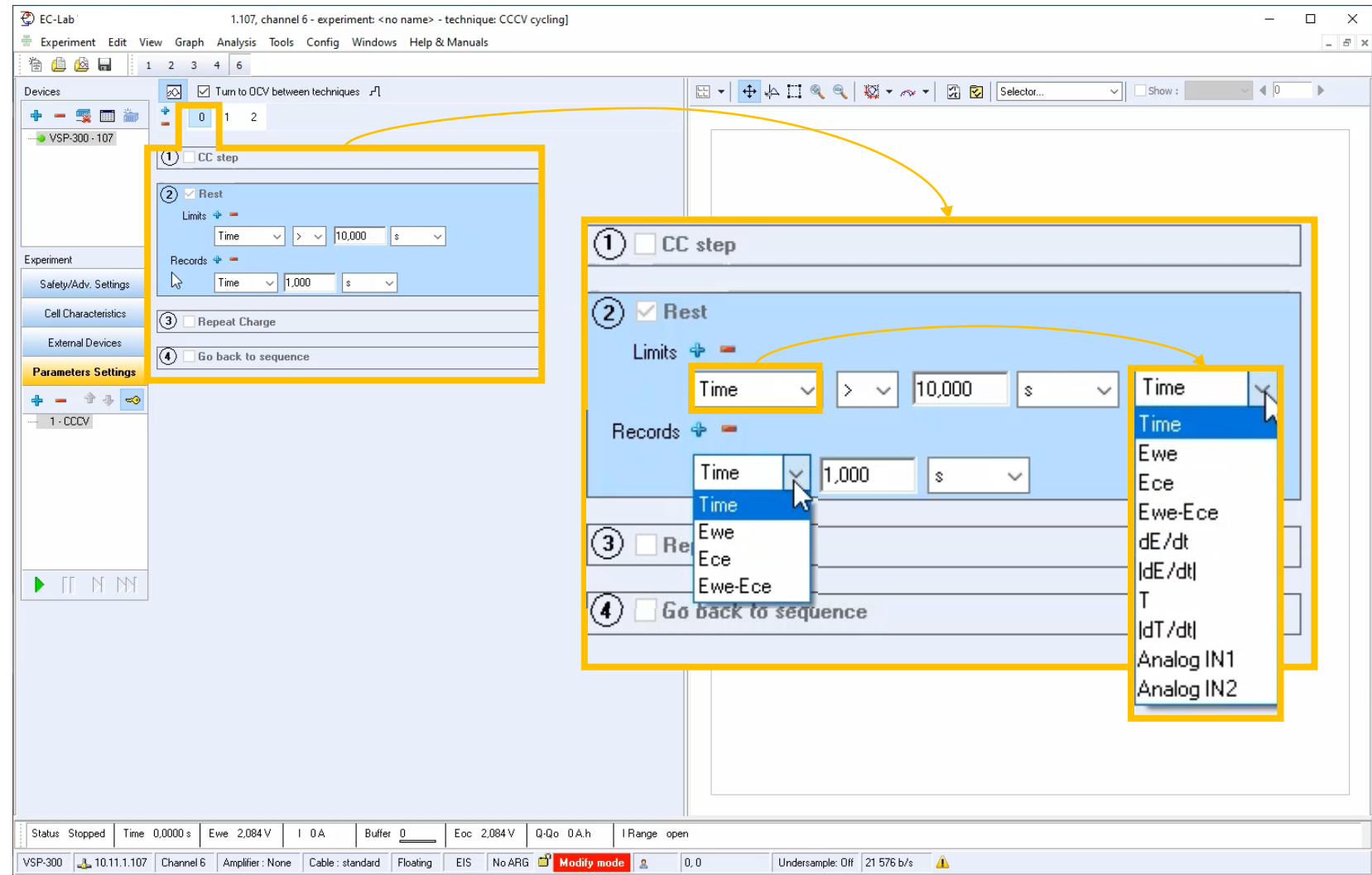
Active block

Non active blocks



## 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

The screenshot displays the EC-Lab software interface for configuring a CCCV experiment. The main workspace shows the 'Parameters Settings' tab, with a sequence editor at the top indicating steps 1, 2, 3, and 4. Step 1 is highlighted with a yellow box and labeled '1'. Two callout boxes provide detailed parameter settings for the 'CC step' and 'CV step'.

**CC step parameters:**

- Charge: 150,000 mA vs. <None>
- Limits: Ewe > 2,500 V, Hold on this limit (CV step)
- Records: Time 1,000 s
- CV step: Ewe in Potentiostat
- Limits: Time > 10,000 s
- Records: Time 1,000 s
- Global limits: E Range 0V; 5V, Resolution = 100  $\mu$ V, I Range 1 A, Bandwidth 8

**CV step parameters:**

- Discharge: 150,000 mA vs. <None>
- Limits: Ewe < 2,200 V, Hold on this limit (CV step)
- Records: Time 10,000 h
- CV step: Ewe in Potentiostat
- Limits: Time > 10,000 s
- Records: Time 1,000 s
- Global limits: E Range 0V; 5V, Resolution = 100  $\mu$ V, I Range 1 A, Bandwidth 8

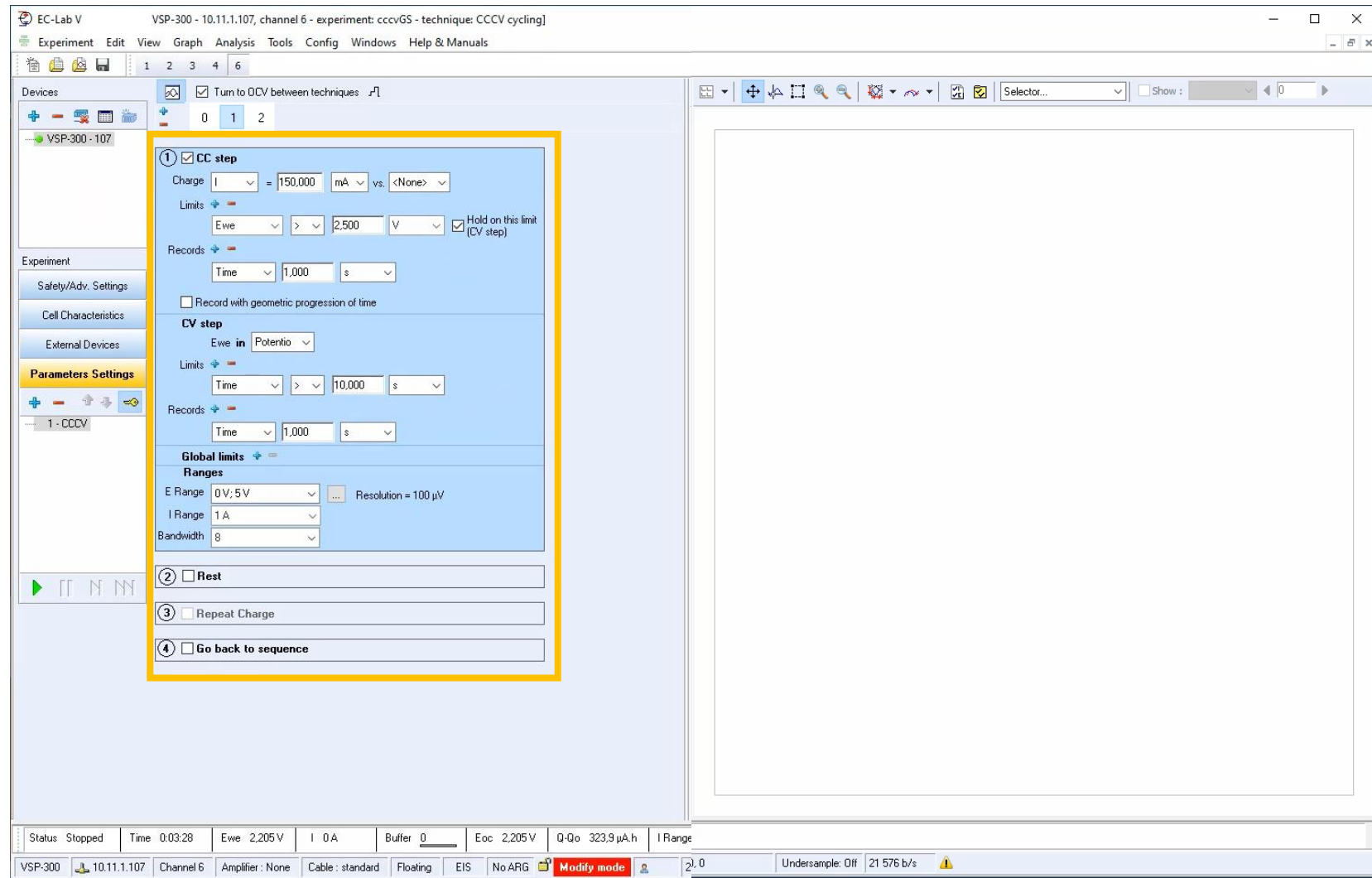
The status bar at the bottom shows: Status Stopped, Time 0.0000 s, Ewe 2.084 V, I 0 A, Buffer 0, Eoc 2.084 V, Q-Qo 0 A.h, I Range open, VSP-300, 10.11.1.107, Channel 6, Amplifier: None, Cable: standard, Floating, EIS, No ARG, Modify mode, 0.0, Undersample: Off, 21 576 b/s.



# 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

EC-Lab V VSP-300 - 10.11.1.107, channel 6 - experiment: cccvGS - technique: CCCV cycling

Experiment Edit View Graph Analysis Tools Config Windows Help & Manuals

Devices: VSP-300 - 107

Experiment: Safety/Adv. Settings, Cell Characteristics, External Devices, Parameters Settings

1 - CCCV

① ☒ CC step

Charge I = 150,000 mA vs. <None>

Limits Ewe > 2,500 V ☒ Hold on this limit (CV step)

Records Time 1,000 s

☐ Record with geometric progression of time

CV step

Ewe in Potentio

Limits Time > 10,000 s

Records Time 1,000 s

☐ Record with geometric progression of time

Global limits

Ranges

E Range 0 V; 5 V Resolution = 100 µV

I Range 1 A

Bandwidth 8

② ☐ Rest

③ ☐ Repeat Charge

④ ☐ Go back to sequence

Status: Stopped Time: 0:03:28 Ewe: 2,205 V I: 0 A Buffer: 0 Eoc: 2,205 V Q-Qo: 323.9 µA.h I Range

VSP-300 10.11.1.107 Channel 6 Amplifier: None Cable: standard Floating EIS No ARG Modify mode 2.0 Undersample: Off 21 576 b/s



## Step 2: Set CCCV parameters

- Set applied current

EC-Lab [VSP-300 - 10.11.1.107, channel 6 - experiment: <no name> - technique: CCCV cycling]

Experiment Edit View Graph Analysis Tools Config Windows Help & Manuals

1 2 3 4 6

Devices

- VSP-300 - 107

Experiment

- Safety/Adv. Settings
- Cell Characteristics
- External Devices
- Parameters Settings

1 - CCCV

Turn to OCV between techniques: ☒

**1 CC step**

Charge **I** = 150,000 mA vs. <None>

Limits **I** > 2,500 V ☒ Hold on this limit (CV step)

Records **Time** 1,000 s

☐ Record with geometric progression of time

**CV step**

Ewe in **Potentio**

Limits **Time** > 10,000 s

Records **Time** 1,000 s

**Global limits**

**Ranges**

E Range 0 V; 5 V Resolution = 100  $\mu$ V

I Range 1 A

Bandwidth

Charge **I**

Limits **I**

C / N

C x N

Diagram: Current (I) vs. Time (t). The current is constant at  $I_s$  for a duration  $t_1$ , then drops to 0 (oc). The limit is defined by Ewe, Ece, Ecell, and  $\Delta Q$ .

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
- **I meas**: the previous measured current, if a technique is set before the CCCV

1 ☒ CC step

Charge I = 150,000 mA vs. <None>

Limits + -

Ewe > 2,500 V ☒ Hold on this limit (CV step)

Time 1,000 s

Record with geometric progression of time

V step

Ewe in Potentio

Time > 10,000 s

Records + -

Time 1,000 s

Global limits + -

Ranges

E Range 0 V; 5 V Resolution = 100 µV

I Range 1 A

Bandwidth 8

Graph: I vs. t. Pulse duration t<sub>1</sub>, amplitude I<sub>s</sub>. Open circuit (oc) regions. Limit: Ewe, Ece, Ecell, ΔQ.



## Step 2: Set CCCV parameters

- Set limit(s) type and value

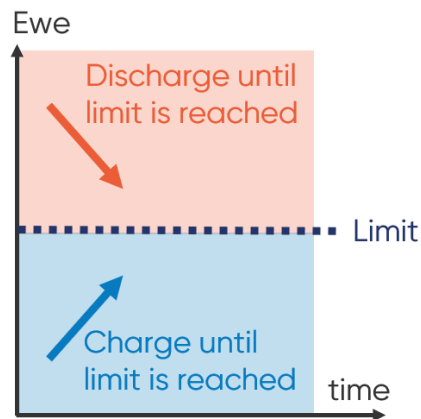
The screenshot displays the EC-Lab software interface for configuring CCCV (Constant Current Constant Voltage) cycling. The 'Limits' section is highlighted with an orange box, showing the 'Ewe' (Working Electrode Potential) limit set to 2,500 V. A dropdown menu is open, listing various parameters that can be monitored during the experiment, including Time, Ewe, Ece, Ewe-Ece, I, |I|, |Q|, Power, |Energy|, dI/dt, |dI/dt|, |ΔSoC|, x, dE/dt, |dE/dt|, |dT/dt|, Analog IN1, and Analog IN2. The graph on the right shows a current (I) vs. time (t) profile with a constant current step labeled  $I_s$  and a 'limit' line. The status bar at the bottom shows 'Status: Stopped' and 'Time: 0,000 s'.

Note: By default, voltage Ewe is the limit



# Step 2: Set CCCV parameters

Sign is automatically updated according to the sign of the current



EC-Lab [VSP-300 - 10.11.1.107, channel 6 - experiment: <no name> - technique: CCCV cycling]

Experiment Edit View Graph Analysis Tools Config Windows Help & Manuals

1 2 3 4 6

Devices

- VSP-300 - 107

Experiment

- Safety/Adv. Settings
- Cell Characteristics
- External Devices
- Parameters Settings

1 - CCCV

Turn to OCV between techniques ☒

1 ☒ CC step

Charge  =  mA vs.

Limits    V ☒ Hold on this limit (CV step)

Records   s

☐ Record with geometric progression of time

CV step

Ewe in

Limits    s

Records   s

Global limits

Ranges

E Range  Resolution = 100  $\mu$ V

I Range

Bandwidth

Status Stopped Time 0,0000 s Ewe 2,084 V I 0 A Buffer 0 Eoc 2,084 V Q-Qo 0 A.h I Range open

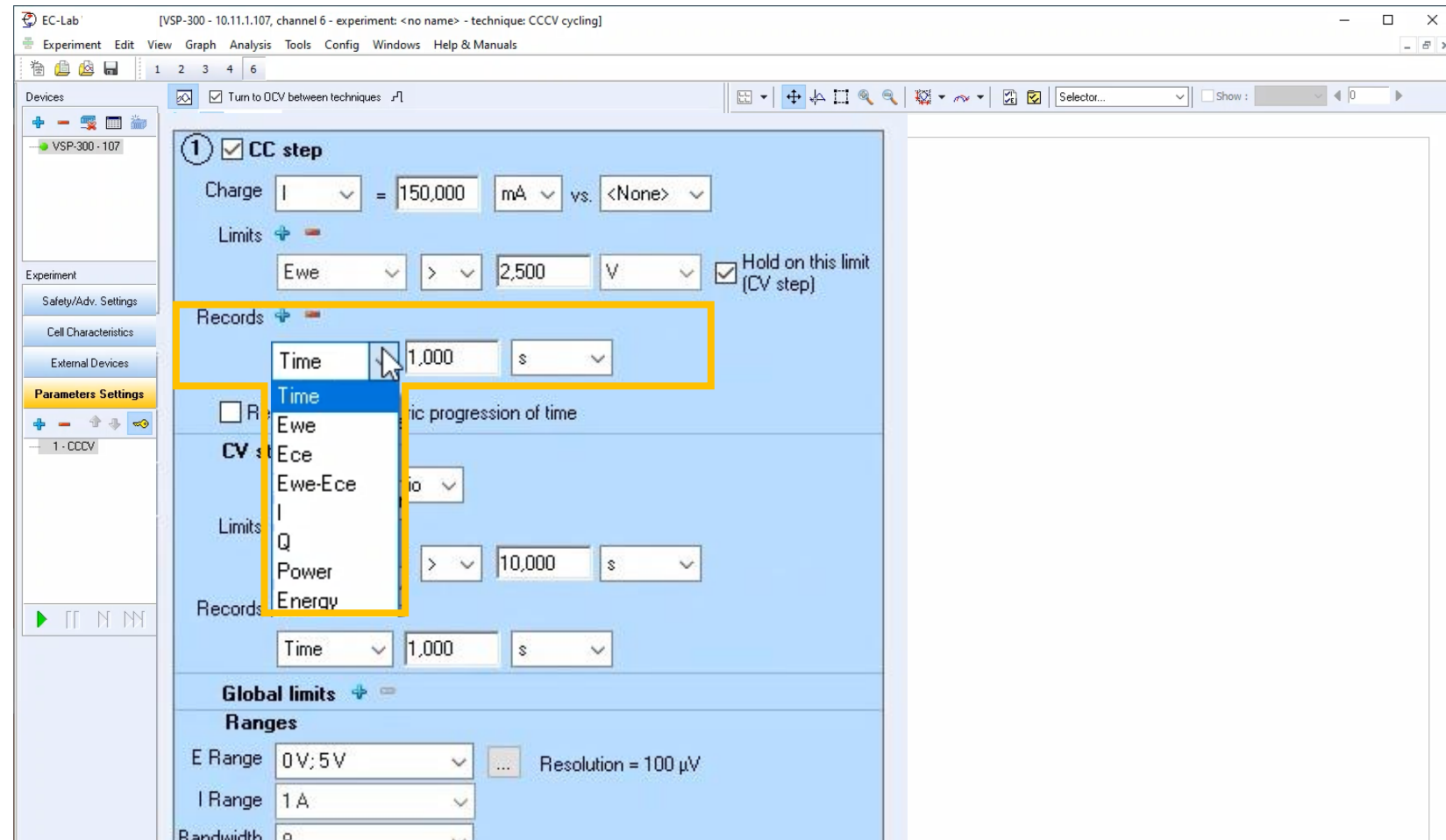
VSP-300 10.11.1.107 Channel 6 Amplifier: None Cable: standard Floating EIS No ARG Modify mode 0, 0 Undersample: Off 21 576 b/s





## Step 2: Set CCCV parameters

- Set record(s) type and value



Note: By default, it is recorded in time



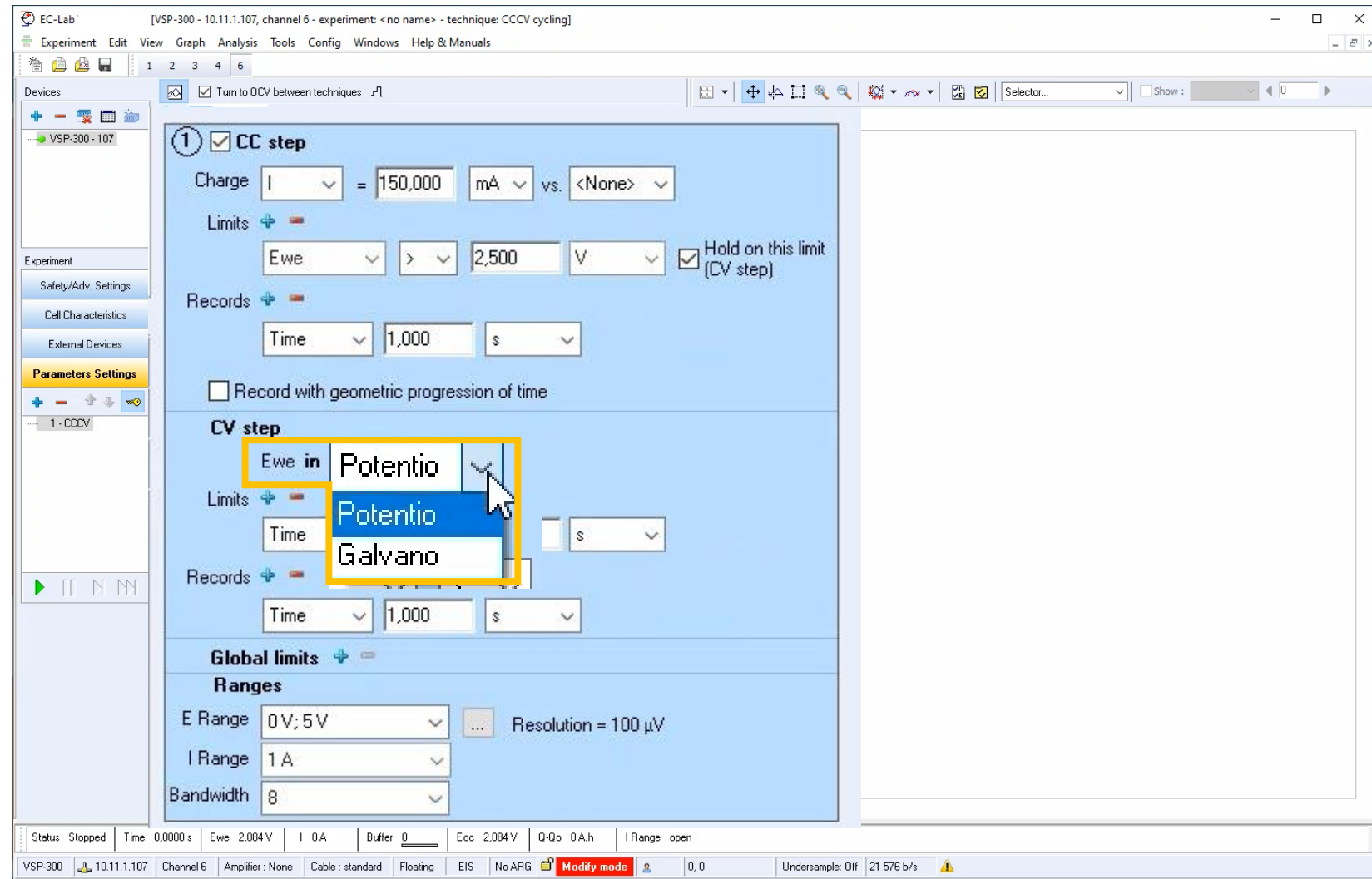
As battery testing may take several months, only the relevant points can be recorded (i.e. variations) depending on selected sampling rate.





## Step 2: Set CCCV parameters

- Select control mode for CV step

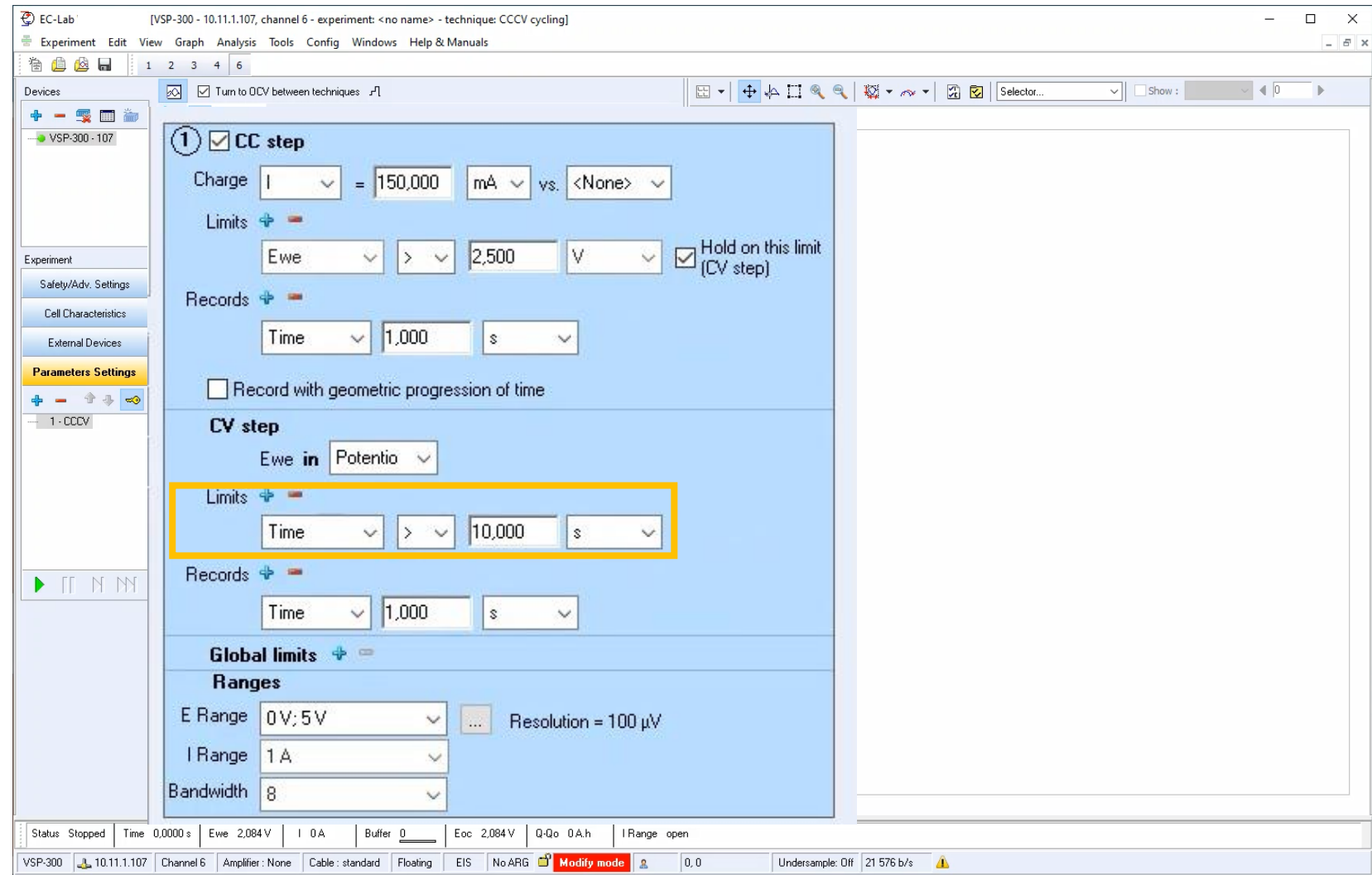


Note: By default, it is potentio



# 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

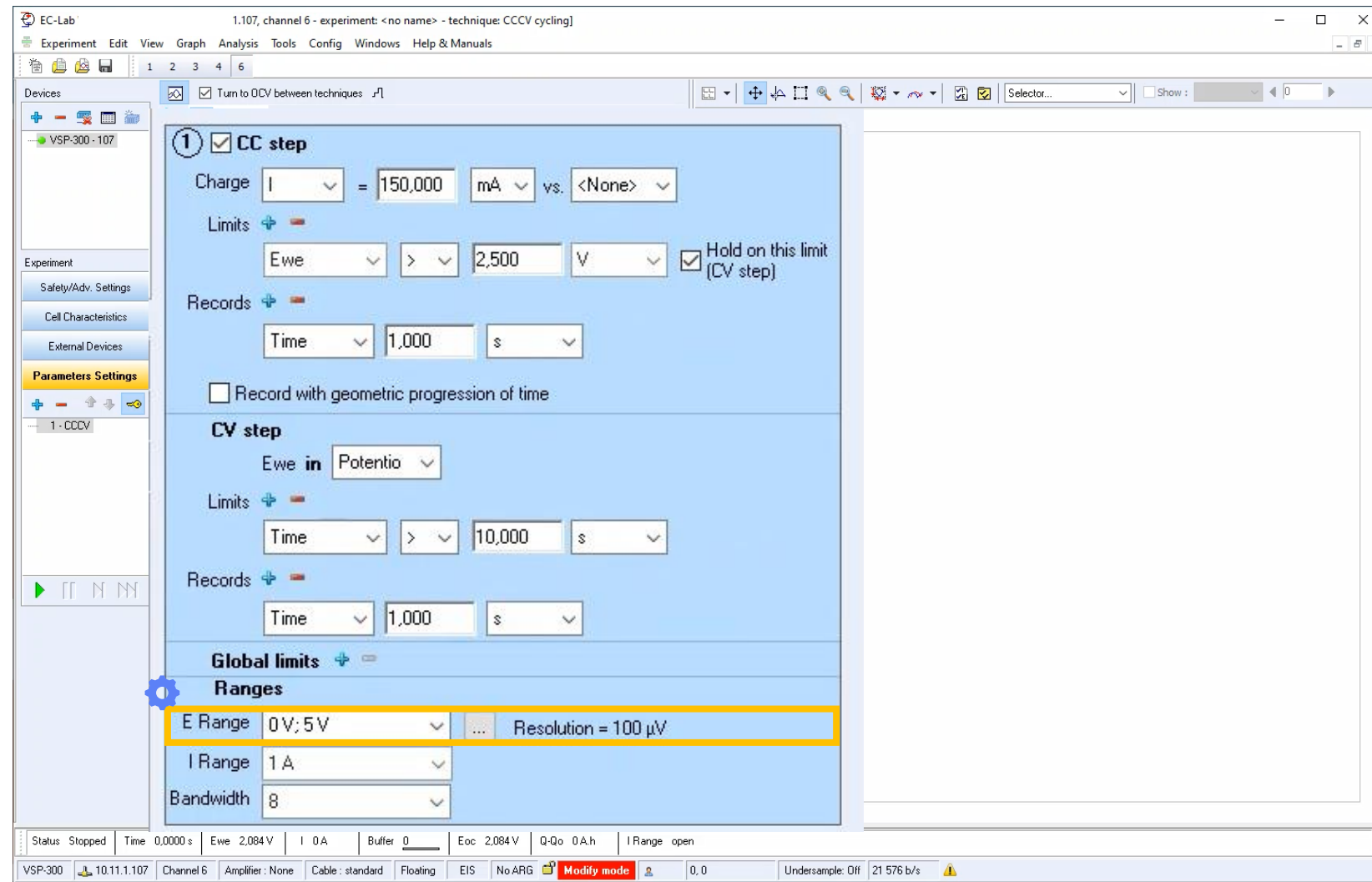
The screenshot shows the EC-Lab software interface for setting CCCV parameters. The window title is "EC-Lab" and the subtitle is "[VSP-300 - 10.11.1.107, channel 6 - experiment: <no name> - technique: CCCV cycling]". The interface includes a menu bar (Experiment, Edit, View, Graph, Analysis, Tools, Config, Windows, Help & Manuals) and a toolbar. On the left, there is a sidebar with "Devices" (VSP-300-107), "Experiment" (Safety/Adv. Settings, Cell Characteristics, External Devices, Parameters Settings), and "1 - CCCV". The main area is divided into sections for "CC step" and "CV step". The "CC step" section includes fields for "Charge" (150,000 mA vs. <None>), "Limits" (Ewe > 2,500 V, Hold on this limit (CV step) checked), and "Records" (Time 1,000 s). A red box highlights the checkbox "Record with geometric progression of time". The "CV step" section includes fields for "Ewe in" (Potentio), "Limits" (Time > 10,000 s), and "Records" (Time 1,000 s). A red box highlights the "Global limits" section, which includes "Ranges" for "E Range" (0 V; 5 V), "I Range" (1 A), and "Bandwidth" (8). The status bar at the bottom shows "Status Stopped", "Time 0,0000 s", "Ewe 2,084 V", "I 0 A", "Buffer 0", "Eoc 2,084 V", "Q-Qo 0 A.h", "I Range open", and "Modify mode".



# 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

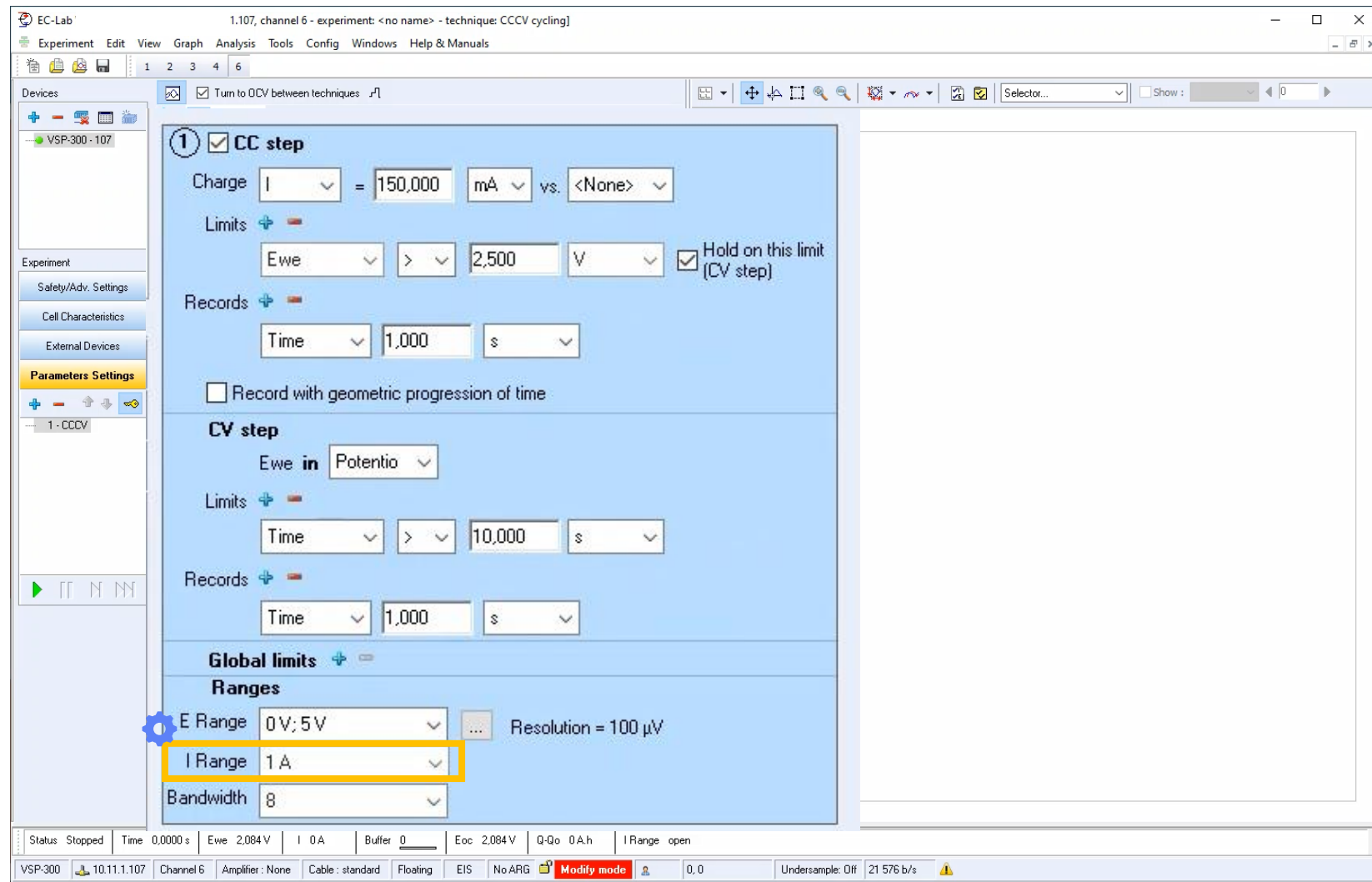




# Step 3: Optimize the measurement

- 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



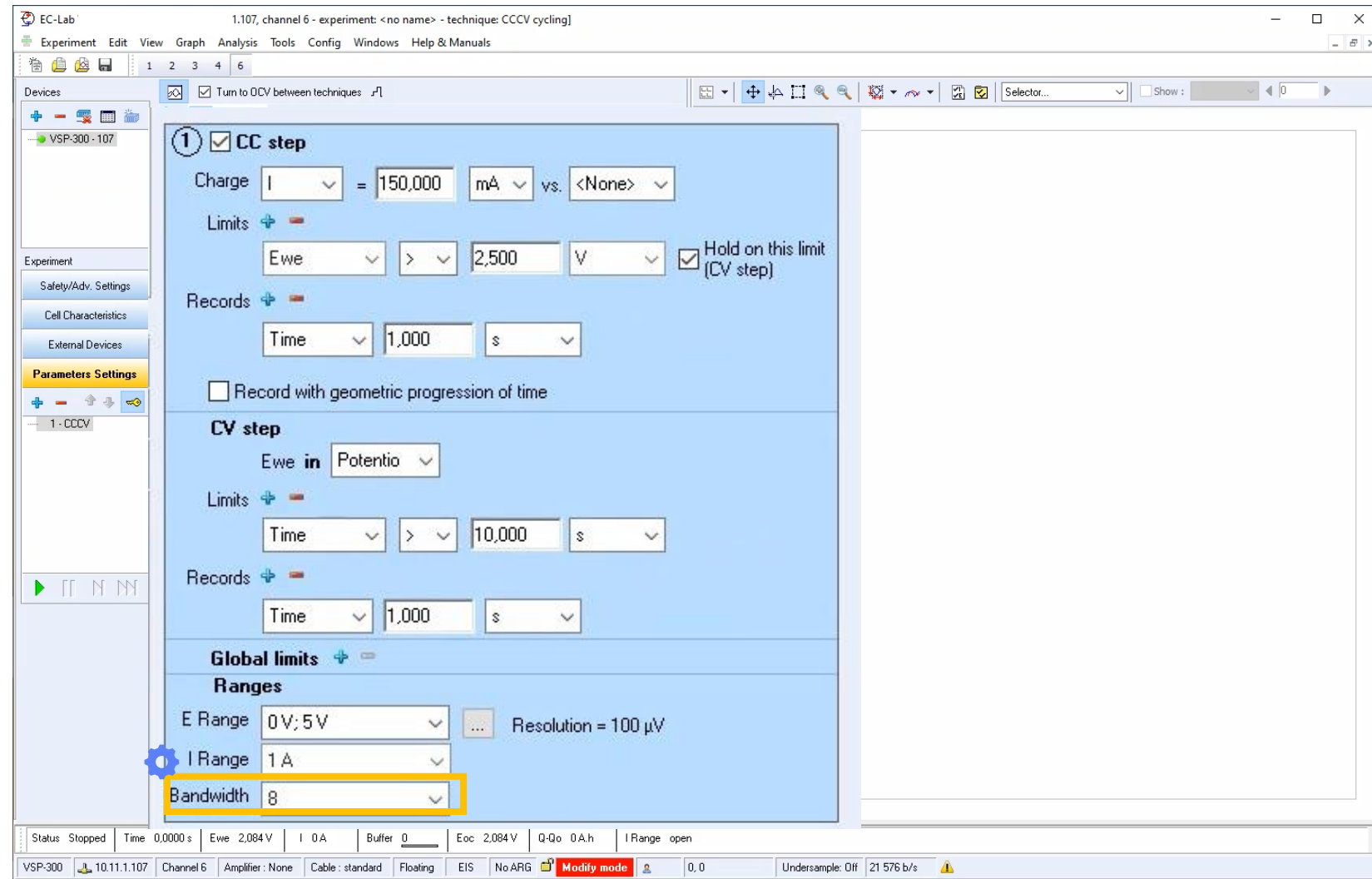


# Step 3: Optimize the measurement

- Adjust bandwidth 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

EC-Lab V11.1 -300 - 10.11.1.107, channel 6 - experiment: <no name> - technique: CCCV cycling

Experiment Edit View Graph Analysis Tools Config Windows Help & Manuals

1 2 3 4 6

Devices

VSP-300 - 107

Experiment

Safety/Adv. Settings

**Cell Characteristics**

External Devices

Parameters Settings

1 - CCCV

Cell Description

Electrode material

Initial state

Electrolyte

Comments

Electrode surface area (A) 0,001 cm²

Characteristic mass 0,001 g

Volume (V) 0,001 cm³

Battery Corrosion Materials

Mass of active material 7000,000 mg at x = 1,000

Molecular weight of active material (at x = 0) 90,930 g

Atomic weight of intercalated ion 6,940 g

Acquisition started at : x0 = 0,900

Number of e- transferred per intercalated ions 1

for Δx = 1, theoretical capacity ΔQ = 1916,936 mA.h

Battery capacity C = 0,000 A.h

Reference Electrode

[unspecified]

Offset potential vs. Normal Hydrogen Electrode: 0,000 V

Status: Stopped Time: 16,2288 s Ewe: 2,214 V I: 0 A Buffer: 0 Eoc: 2,214 V Q-Qo: 260,1 μA.h I Rann

VSP-300 10.11.1.107 Channel 6 Amplifier: None Cable: standard Floating EIS No ARG Read mode -3,0, 0 Undersample: Off 21 866 b/s

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

The screenshot shows the EC-Lab V11.1 software interface. The 'Cell Characteristics' section is active, and the 'Battery' tab is selected. A red box highlights the 'Battery' tab and its parameters. The parameters include:

- Mass of active material: 7000.000 mg at x = 1.000
- Molecular weight of active material (at x = 0): 90.930 g
- Atomic weight of intercalated ion: 6.940 g
- Acquisition started at: x<sub>0</sub> = 0.900
- Number of e<sup>-</sup> transferred per intercalated ions: 1
- for  $\Delta x = 1$ , theoretical capacity  $\Delta Q = 1916.936$  mAh
- Battery capacity C = 0.000 Ah

The 'Reference Electrode' section shows 'Offset potential vs. Normal Hydrogen Electrode: 0.000 V'.

The status bar at the bottom shows: Status: Stopped, Time: 16,2288 s, Ewe: 2.214 V, I: 0 A, Buffer: 0, Eoc: 2.214 V, Q-Qo: 260.1  $\mu$ A.h, I Rann.

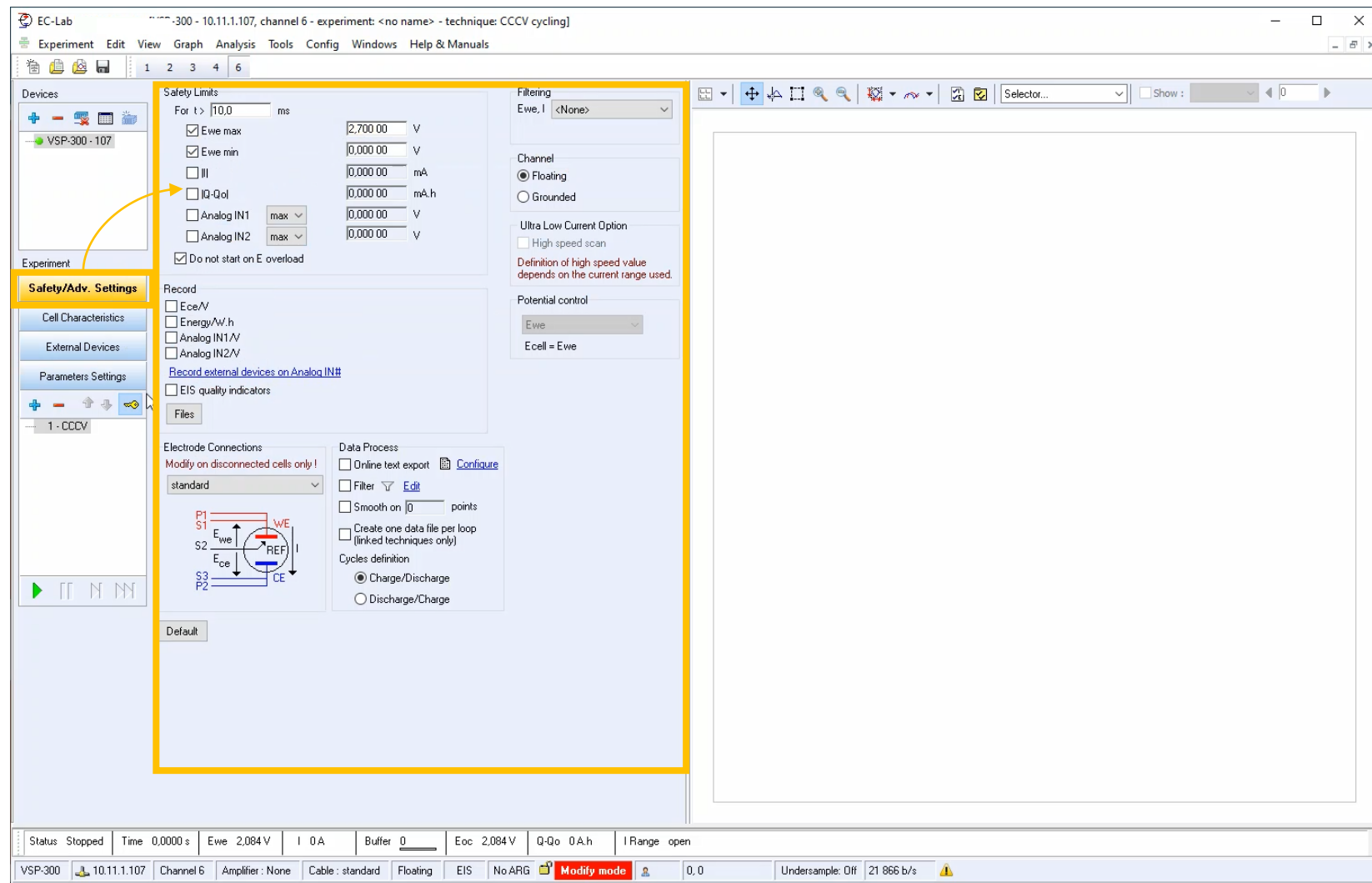




# Step 4: Set general parameters

- Safety and Advanced Settings are available here

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



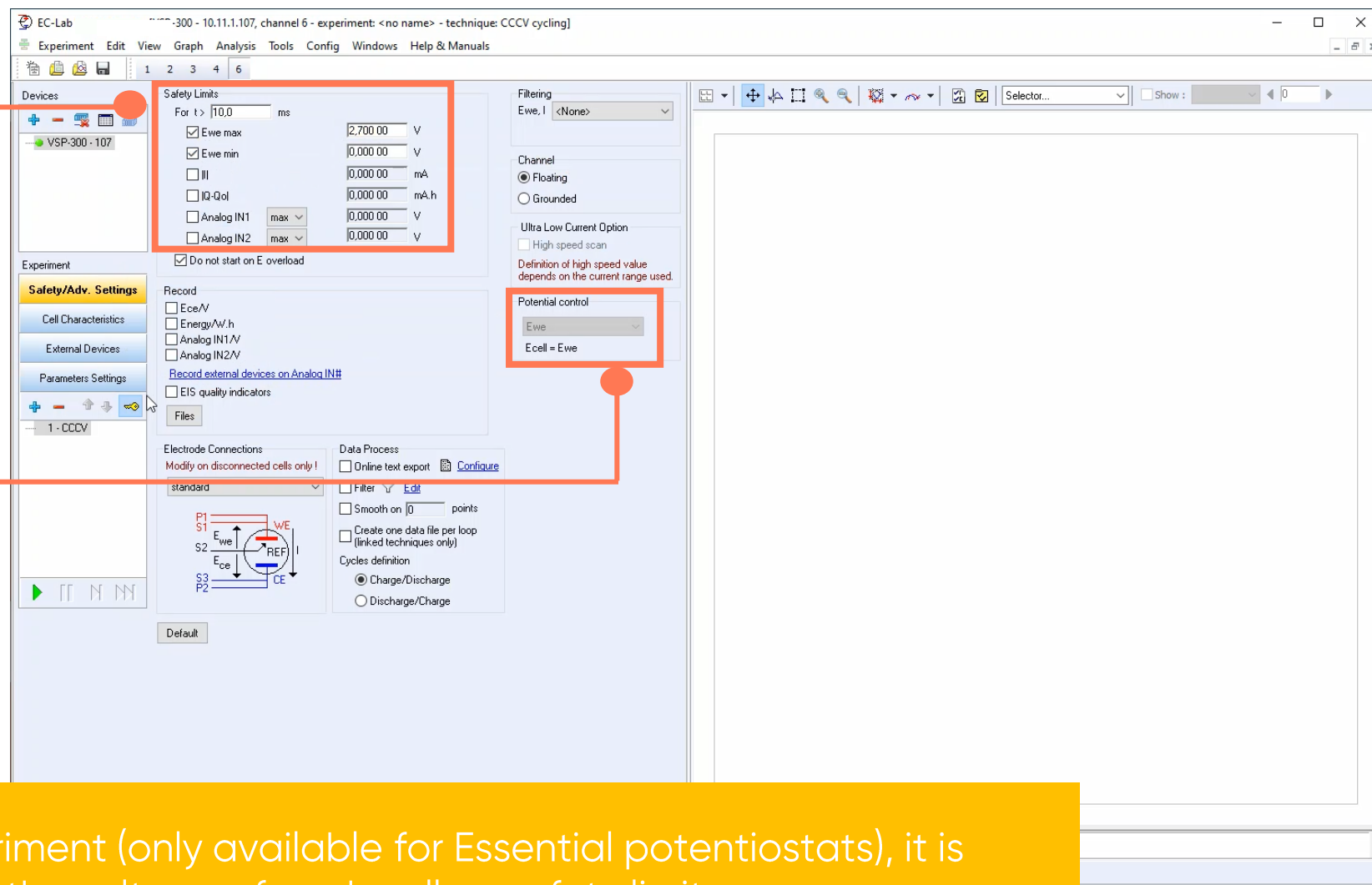


# Step 4: Set general parameters

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)

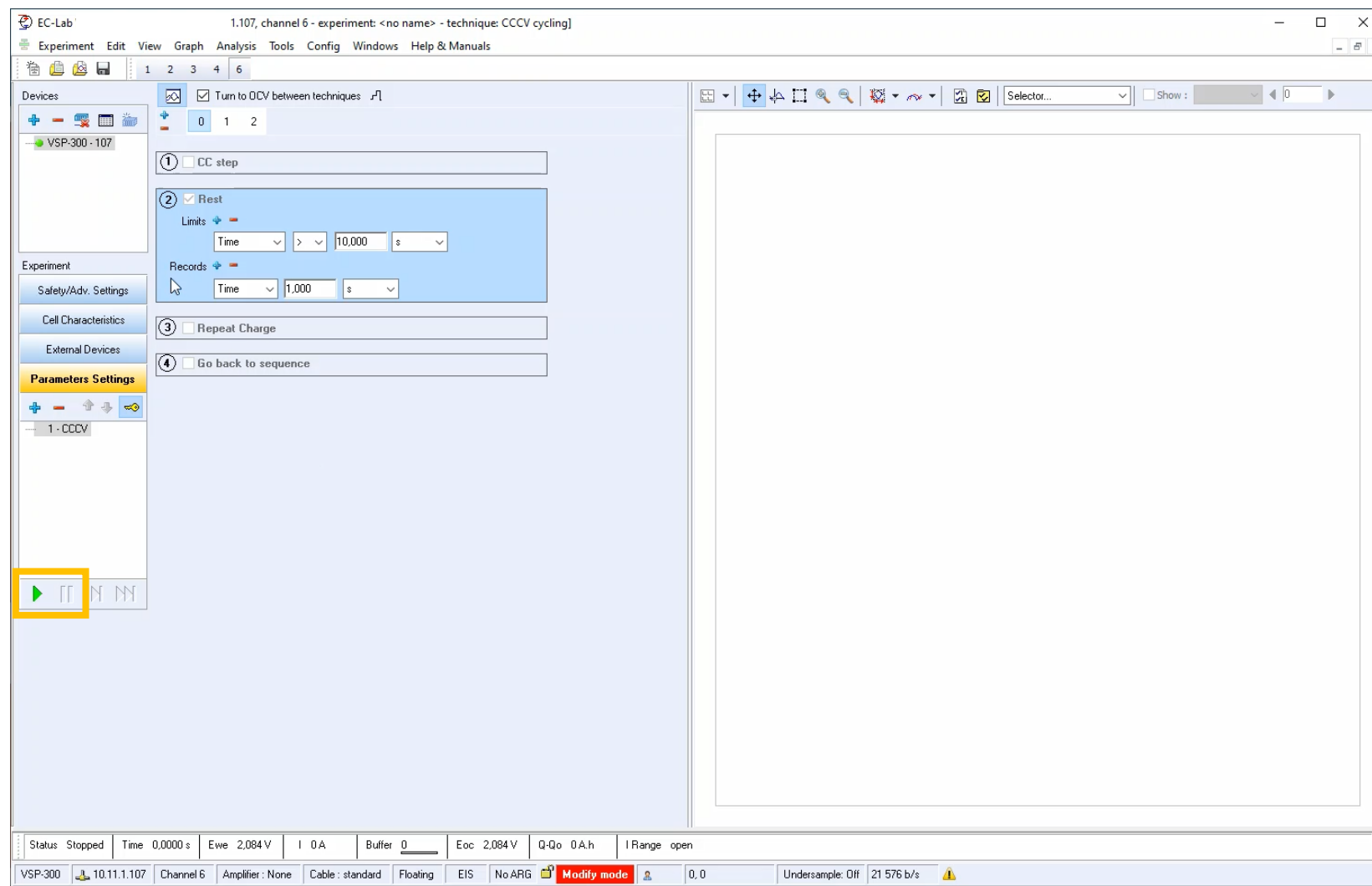


For stack experiment (only available for Essential potentiostats), it is possible to use the voltage of each cell as safety limits.



# 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

The screenshot displays the VSP-300 software interface. The top menu bar includes Experiment, Edit, View, Graph, Analysis, Tools, Config, Windows, and Help & Manuals. The left sidebar shows a tree view with 'VSP-300-107' selected under 'Devices', and 'Parameters Settings' selected under 'Experiment'. The main window shows the 'Parameters Settings' for '1 - CCCV'. The 'Limits' section has 'Time' set to '10,000 s'. The 'Records' section has 'Time' set to '1,000 s'. The 'Sequence' section has 'CC step' selected. The 'Status' section shows 'Status Stopped'. The 'Next technique' and 'Next sequence' buttons are visible. The bottom status bar shows 'Status Stopped', 'Time 0,0000 s', 'Ewe 2,084 V', 'I 0 A', 'Buffer 0', 'Eoc 2,084 V', 'Q-Qo 0 A.h', 'I Range open', and 'Modify mode'.

Stop experiment

Pause experiment

Status Stopped

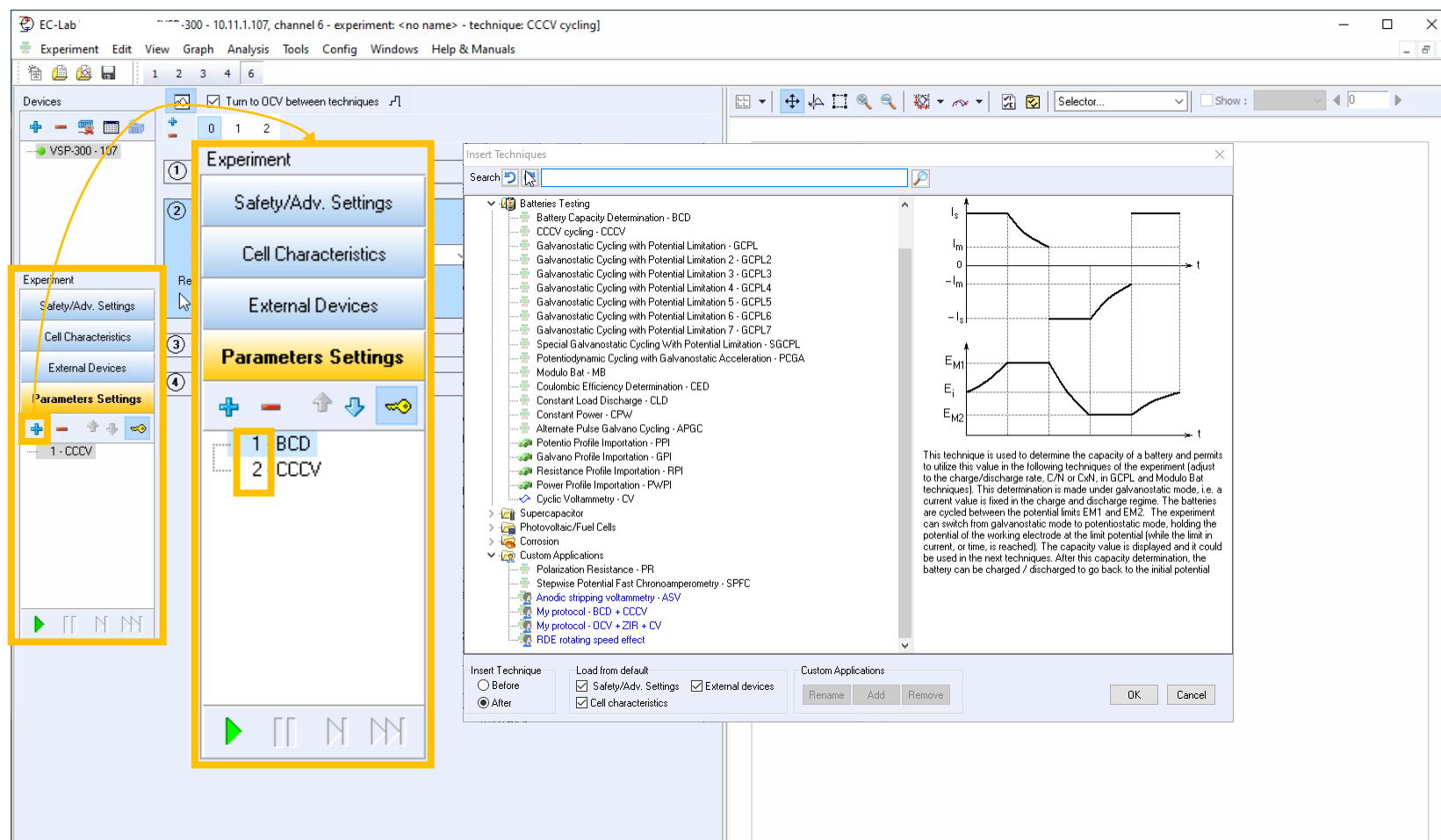
Next technique

Next sequence



# 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)

The screenshot displays the EC-Lab software interface for configuring a battery experiment. The main window is titled "[VSP-300 - 10.11.1.107, channel 6 - experiment: <no name> - technique: 1/2 Battery Capacity Determination]". The left sidebar shows the "Devices" list with "VSP-300 - 107" selected, and the "Experiment" section with "Parameters Settings" highlighted. The central panel shows the configuration for the "1 - BCD" technique, including current limits, recording rates, and a "Result" section showing "Capacity = 0.000 mA.h". A red box highlights the "Result" section, and a red arrow points from the text on the left to this box. The right sidebar shows a list of available techniques, with "Batteries Testing" expanded. A small graph on the right shows current ( $I_s$ ) and potential ( $E_M$ ) versus time ( $t$ ). The bottom status bar shows "VSP-300 off line", "Channel 6", and "Modify mode".

EC-Lab 1 [VSP-300 - 10.11.1.107, channel 6 - experiment: <no name> - technique: 1/2 Battery Capacity Determination]

Experiment Edit View Graph Analysis Tools Config Windows Help & Manuals

Devices

- VSP-300 - 107

Experiment

- Safety/Adv. Settings
- Cell Characteristics
- External Devices
- Parameters Settings**

1 - BCD  
2 - CCCV

Turn to OCV between techniques ☐

Set  $I_1$  to  $I_{s1} = 260,000$  mA  
for  $t_1 = 11$  h 0 mn 0,000 0

Limit  $E_{we} > E_{M1} = 4,200$  V vs. Ref  
and  $E_{we} < E_{M2} = 2,700$  V vs. Ref

Record every  $dE_{we} 1 = 0,0$  mV  
or  $dt_1 = 10,000 0$  s

Hold  $E_{M1}$  (on charge) once reached  
for  $t_M = 1$  h 0 mn 0,000 0  
Limit  $I_M < 1$  mA  
with  $I_M = 130,000$  mA

Record every  $dt_1$

E Range = 0 V; 5 V  
Resolution = 100  $\mu$ V

I Range = 1 A  
Bandwidth = 8

Rest for  $t_R = 0$  h 0 mn 0,000 0  
Limit  $|dE_{we} / dt| < dE_R / dt = 0,0$  mV/h  
Record every  $dE_{we} R = 0,0$  mV  
or  $dt_R = 0,000 0$  s

☒ Discharge with the same rate  
Set  $I$  to  $I_{s2} = -260,000$  mA  
for  $t_2 = 11$  h 0 mn 0,000 0

☐ Return to initial potential

Result: **Capacity = 0.000 mA.h**  
☒ use the capacity value in the following techniques

Insert Techniques

Search

- Batteries Testing
  - Battery Capacity Determination - BCD
  - CCCV cycling - CCCV
  - Galvanostatic Cycling with Potential Limitation 2 - GCPL2
  - Galvanostatic Cycling with Potential Limitation 3 - GCPL3
  - Galvanostatic Cycling with Potential Limitation 4 - GCPL4
  - Galvanostatic Cycling with Potential Limitation 5 - GCPL5
  - Galvanostatic Cycling with Potential Limitation 6 - GCPL6
  - Galvanostatic Cycling with Potential Limitation 7 - GCPL7
  - Special Galvanostatic Cycling With Potential Limitation - SGCPCL
  - Potentiodynamic Cycling with Galvanostatic Acceleration - PCGA
  - Modulo Bat - MB
  - Coulombic Efficiency Determination - CED
  - Constant Load Discharge - CLD
  - Constant Power - CPW
  - Alternate Pulse Galvano Cycling - APGC
  - Potential Profile Importation - PPI
  - Galvano Profile Importation - GPI
  - Resistance Profile Importation - RPI
  - Power Profile Importation - PWPI
  - Cyclic Voltammetry - CV
- Supercapacitor
- Photovoltaic/Fuel Cells
- Corrosion
- Custom Applications
  - Polarization Resistance - PR
  - Stepwise Potential Fast Chronoamperometry - SPFC
  - Anodic stripping voltammetry - ASV
  - My protocol - BCD + CCCV
  - My protocol - OCV + ZIR + CV
  - RDE rotating speed effect

Insert Technique  
☐ Before  
☒ After

Load from default  
☒ Safety/Adv. Settings  
☒ External devices  
☒ Cell characteristics

Custom Applications  
Rename Add Remove

OK Cancel

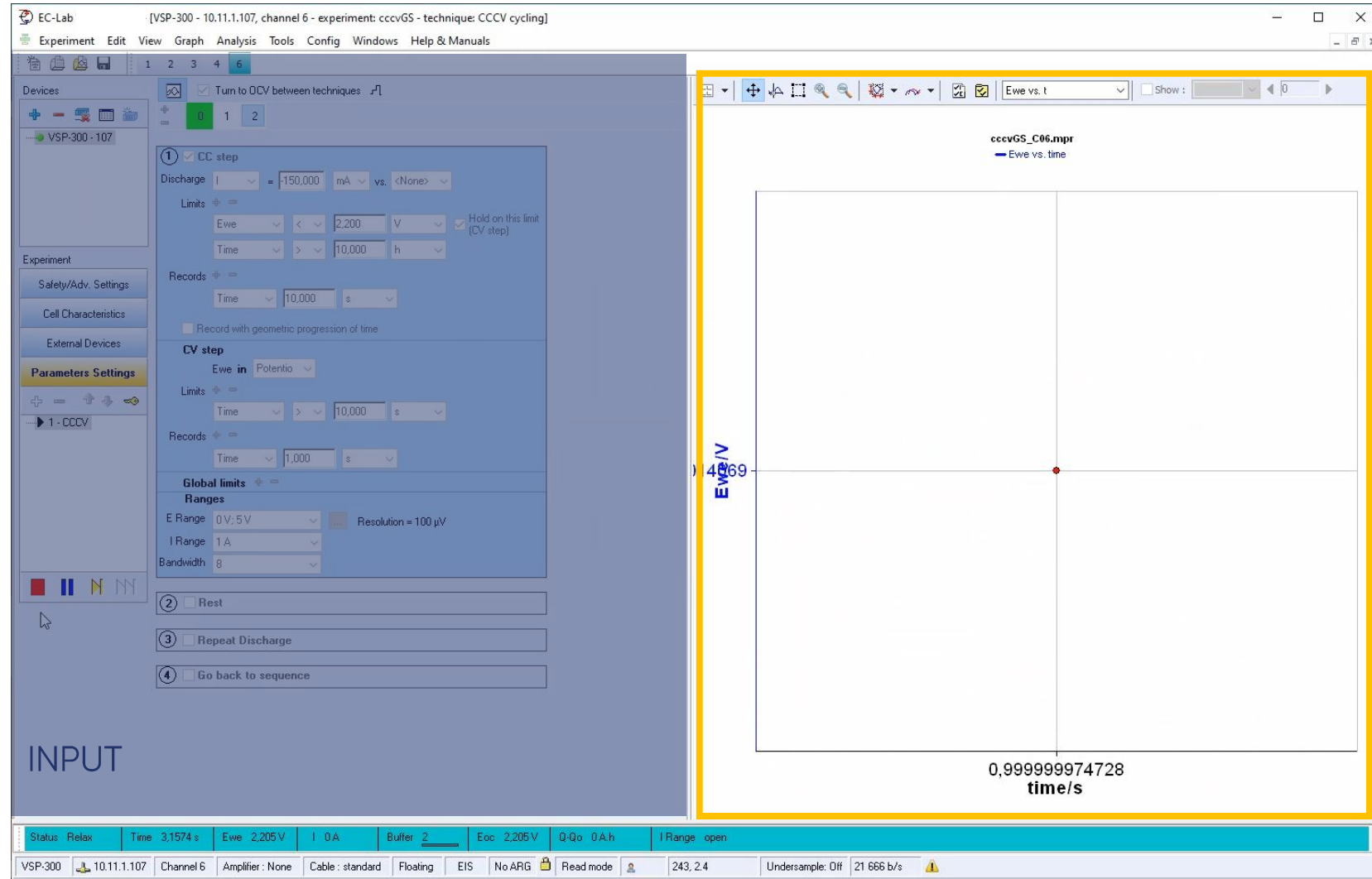
Status Time Ewe I Buffer Eoc Q-Qo I Range Tech

VSP-300 off line Channel 6 Amplifier: None Cable: standard Floating EIS ARG Modify mode 0,0 Undersample: Off 0 b/s



# Step 7: Read the graph

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



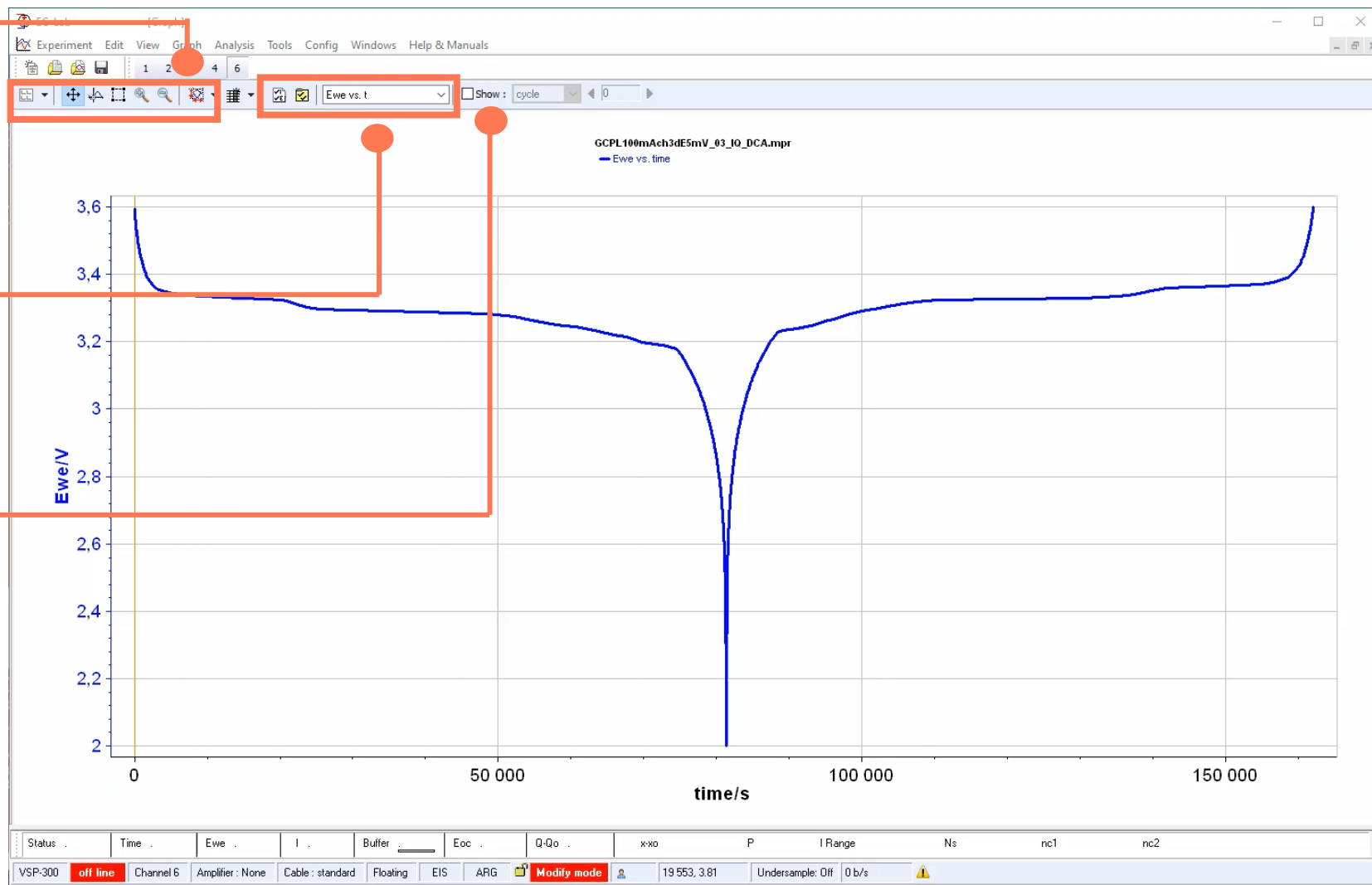


# Step 7: Read the graph

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

Modify the graph  
(Selector, graphic properties, representations)

Show only selected cycle

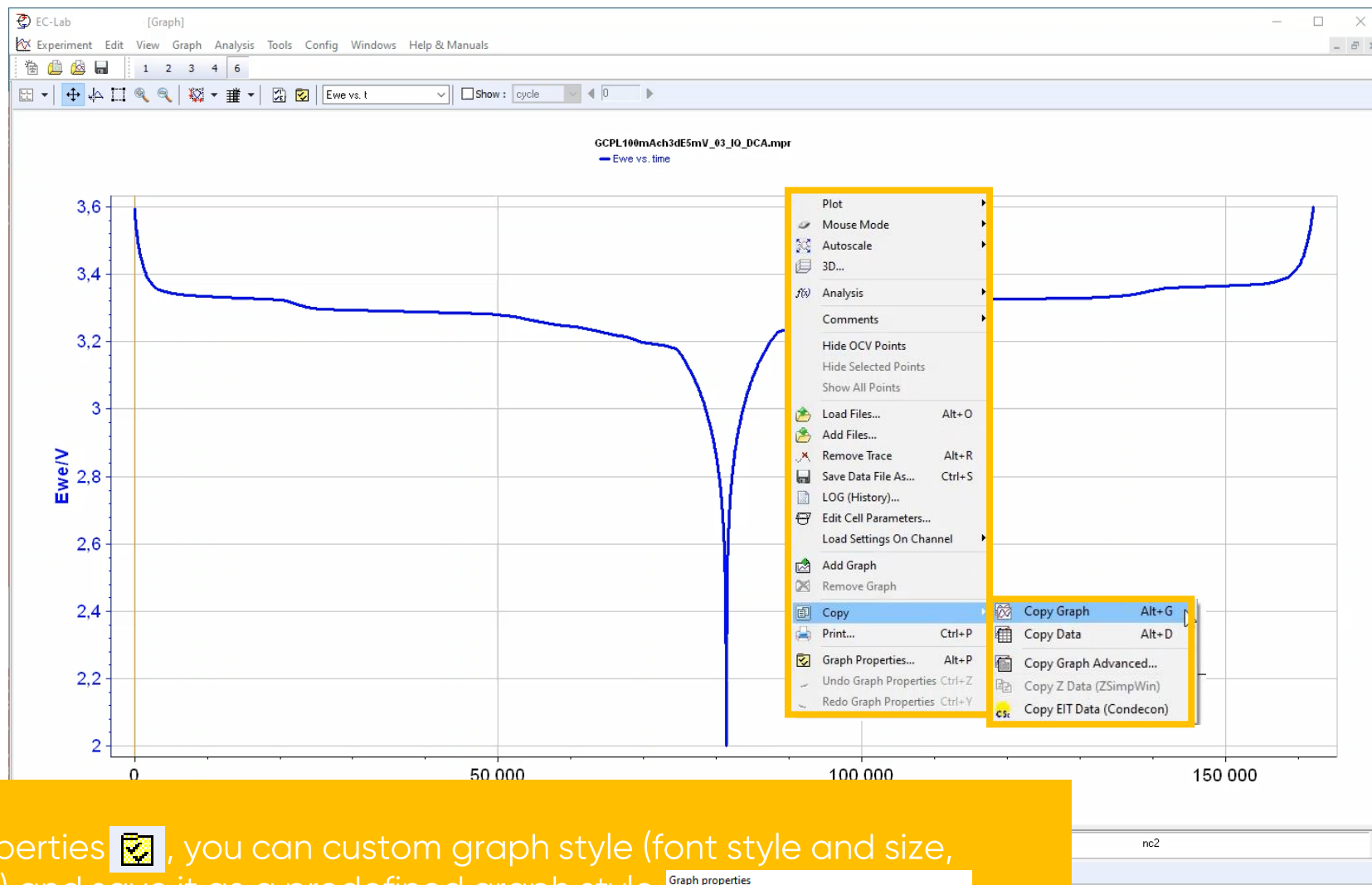






# Step 7: Read the graph

- 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 shortcut in the graph bar, or with F6

The screenshot displays the EC-Lab software interface. The top graph shows a potential vs. time plot with a blue line. The bottom graph shows a current vs. time plot with a blue line. The 'Analysis' menu is open in both graphs, showing the 'Process Data' option highlighted. The 'Process Data' dialog box is open, showing the 'Input Files' section with a file path, and the 'Variables' section with a list of variables to be added. The 'Process' section at the bottom has checkboxes for 'Allow Reprocessing', 'Export As Text', and 'Cycles definition' set to 'Automatic'.

**Process Data**

**Input Files**

C:\Users\olivia.blanc\Documents\EC-Lab\Data\Samples\Battery\GCPL100mAh3dE5mV\_03\_DCA.mpr

Technique : Galvanostatic Cycling with Potential Limitation  
Processed File : C:\Users\olivia.blanc\Documents\EC-Lab\Data\Samples\Battery\GCPL100mAh3dE5mV\_03\_DCA.mpr

**Variables**

To select from the input file

- ☒ mode
- ☒ ox/red
- ☒ error
- ☒ control changes
- ☒ Ns changes
- ☒ counter inc.
- ☒ time/s
- ☒ control/V/mA
- ☒ Ewe/V
- ☒ dq/mA.h
- ☒ Pwe/W
- ☒ (Q-Qo)/mA.h
- ☒ Q charge/discharge/mA.h
- ☒ half cycle

To be added

- ☒ <I>/mA
- ☒ (Q-Qo)/mA.h
- ☐ x
- ☐ cycle number
- ☐ Q charge/mA.h
- ☐ Q discharge/mA.h
- ☐ Energy we/W.h
- ☐ Energy we charge/W.h
- ☐ Energy we discharge/W.h
- ☐ cycle time/s
- ☐ step time/s
- ☐ charge time/s
- ☐ discharge time/s
- ☐ d(Q-Qo)/dE/mA.h/V

**Process**

Keep only values at the end of every ☐ open circuit period ☐ I on period

☒ Allow Reprocessing Cycles definition Automatic

☐ Export As Text ☐ Count half cycles

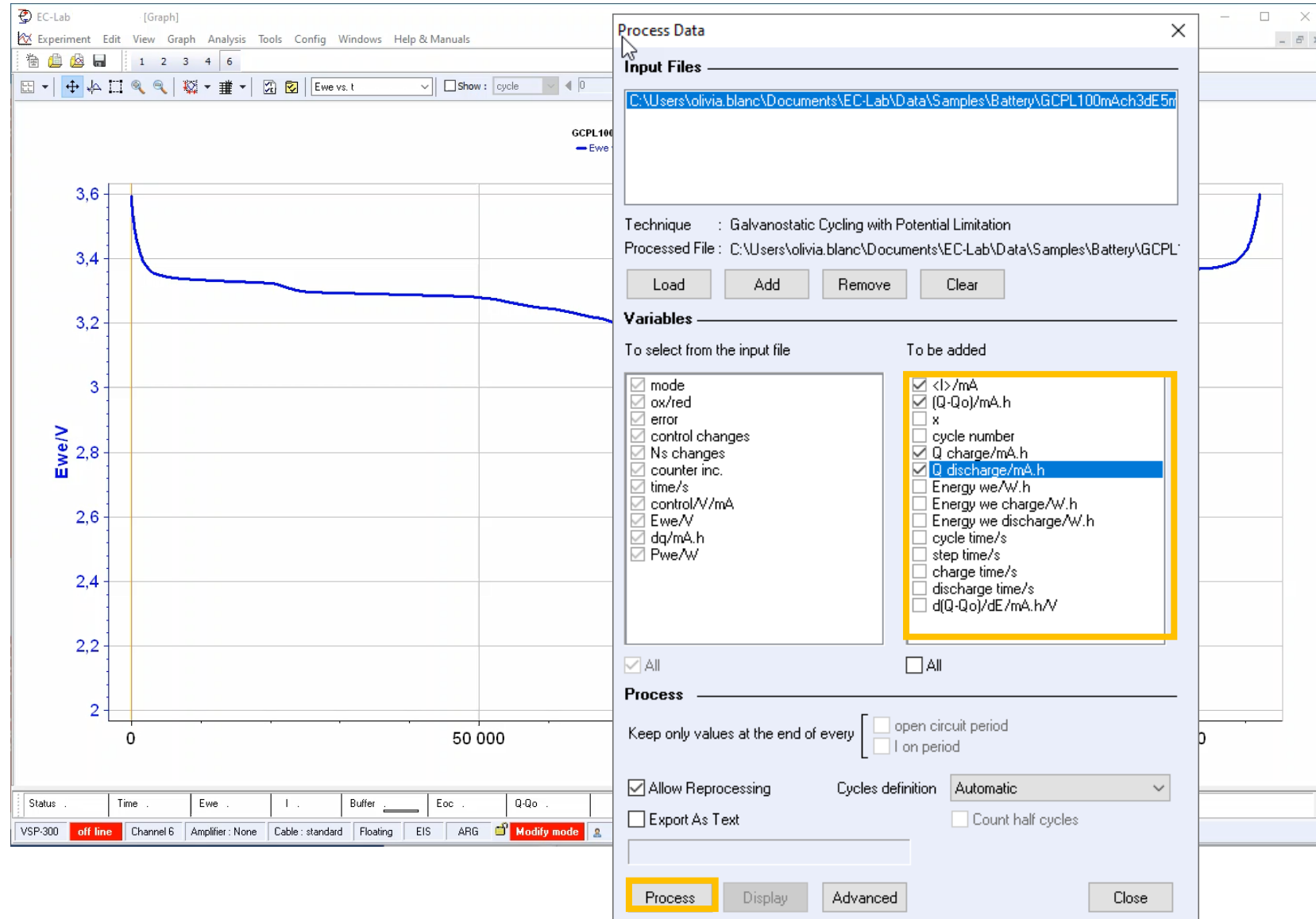
Process Display Advanced Close



# 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

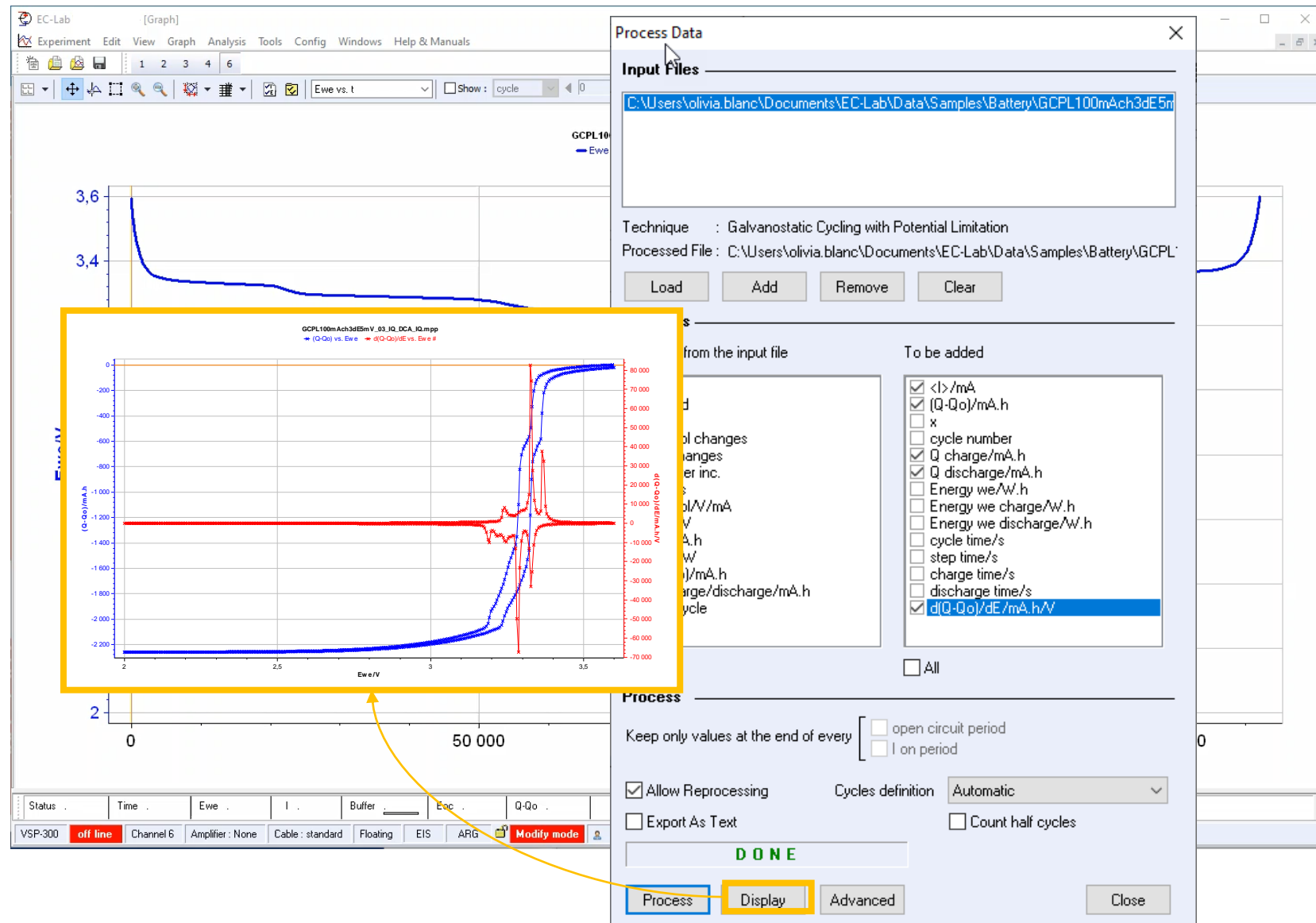




# Step 8: Analyse the data with Process Data

- Display the result

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



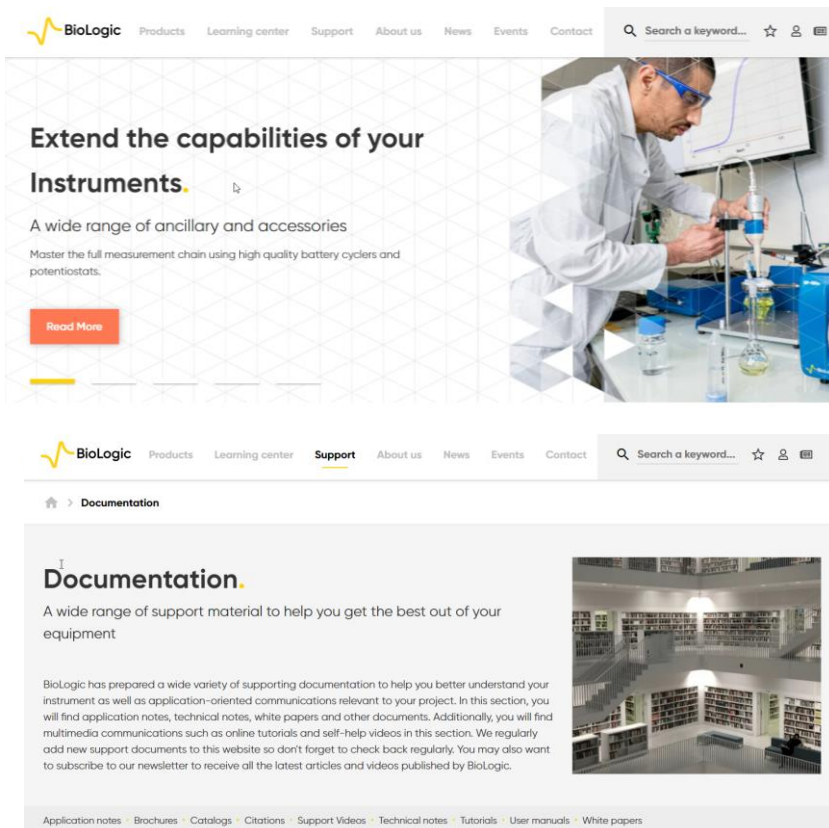


Find out more



# For supplementary information

## Visit our website!



- 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!



- 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



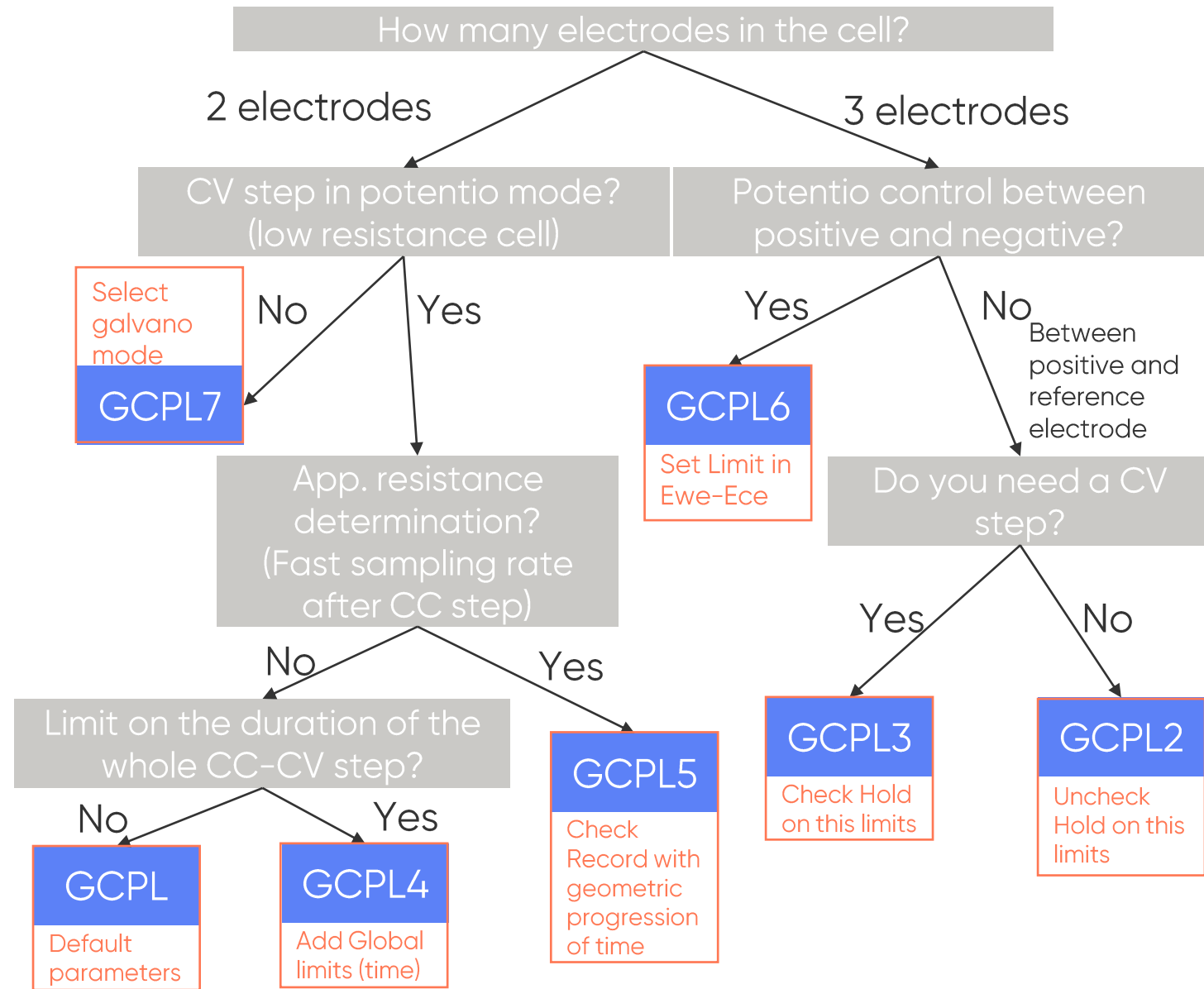
# FAQ

- 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 =  $\pm 12$  V
  - For Essential: compliance = 20 V adjustable from  $\pm 10$  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  $20$  V to allow measurements up to  $20$  V.

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

Compliance

Modify on disconnected cells only !

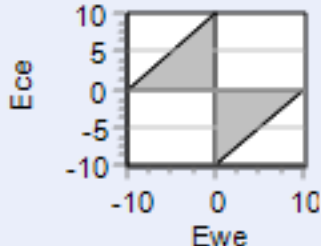
Ewe from  $-10$  V   $10$  V

Ece from  $-10$  V   $10$  V


<< Less information

Ex : if Ewe = **1.00** V

then Ece must be between  $-9.000$  V and  $0$  V.



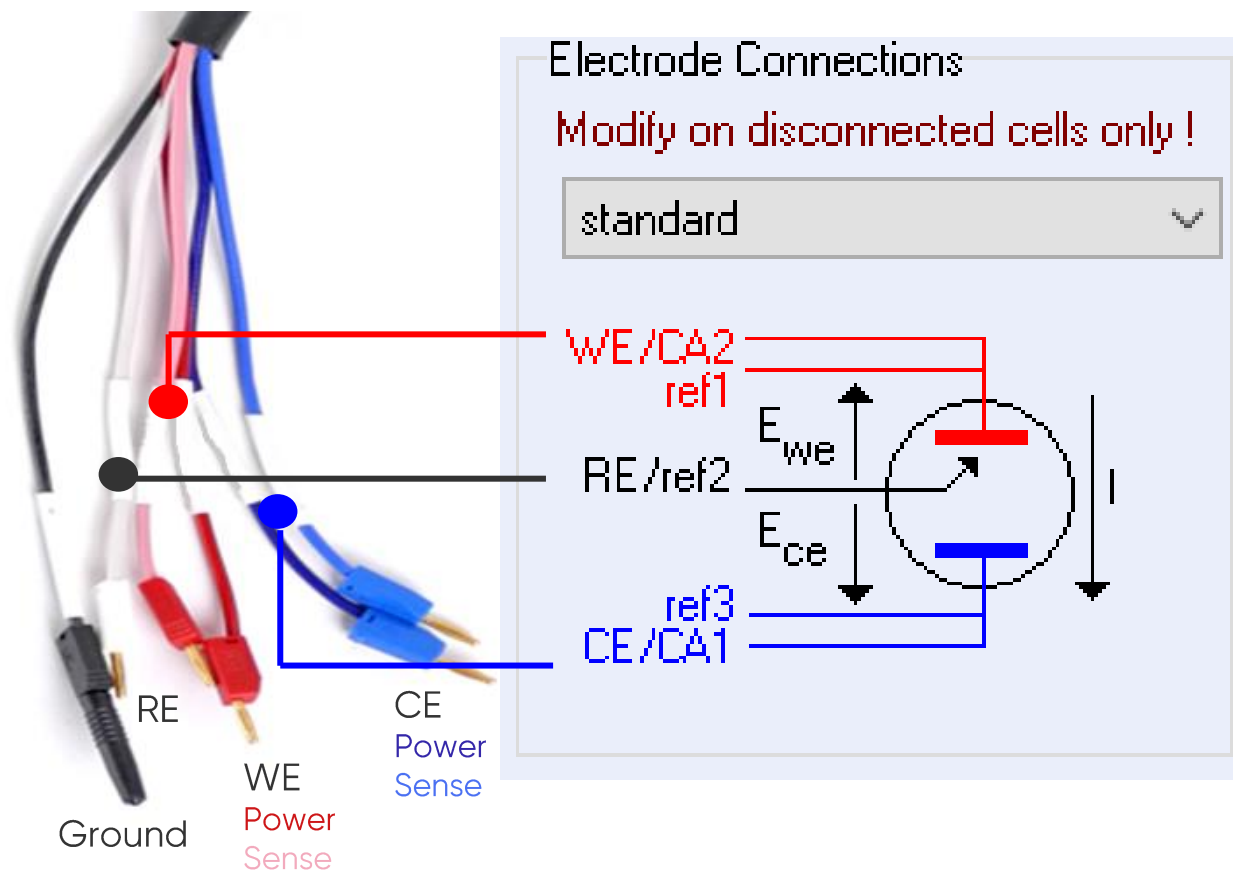
Potential control

Ewe 

Ecell = Ewe



# 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

The screenshot displays the TCU software interface with several configuration panels. The 'Analog Com' panel is highlighted with a yellow box and contains the following settings:

- Device Type:** Temperature Probe
- Device Name:** PT100-BL1 (selected from a dropdown menu showing PT100-BL1, PT100-BL2, CPT100, and Other)
- Custom Units:** (button)
- Analog OUT:** ☒ Convert E/V
- with:** 10 V = 10 V (max), 0 V = 0 V (min)
- E/V:** 10.0

The 'Analog IN1' panel shows:

- ☒ Convert E/V to T/°C
- with:** 0.137 V = 100 °C (max), 0.099 V = 0 °C (min)

The 'Analog IN2' panel shows:

- ☐ External Control
- ☐ Convert E/V to (dropdown)
- with:** 0 V = 0 (max), 0 V = 0 (min)

The 'TCU Digital Com' panel is also highlighted with a yellow box and contains:

- Climatic chamber:** REGULATOR BINDER-MB2 (selected from a dropdown menu showing <None>, REGULATOR WATLOW-F4T, and REGULATOR BINDER-MB2)
- Temperature is controlled by a channel with TCU technique or by default parameters**

On the right side, a sidebar menu includes 'Safety/Adv. Settings', 'Cell Characteristics', 'External Devices' (highlighted in yellow), and 'Parameters Settings'. Below the menu are control buttons: a green play button, a stop button, and a refresh button.



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[contact@biologic.net](mailto:contact@biologic.net)



BioLogic



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for choosing us!**