Getting Started with EC-Lab®:

Tafel Plot

Getting Started EC-Lab: Tafel

V1

March 2024

Overview and quick access

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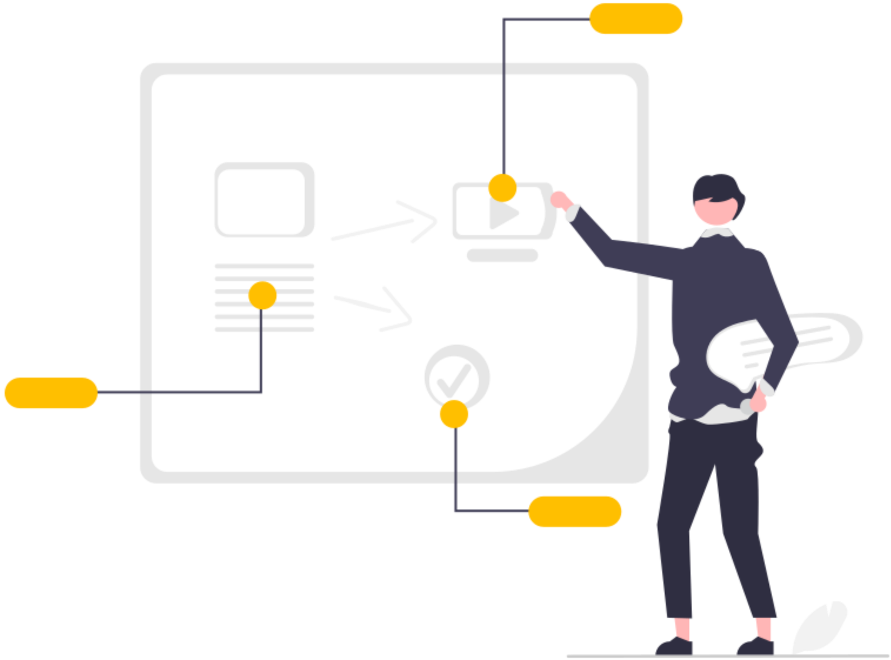
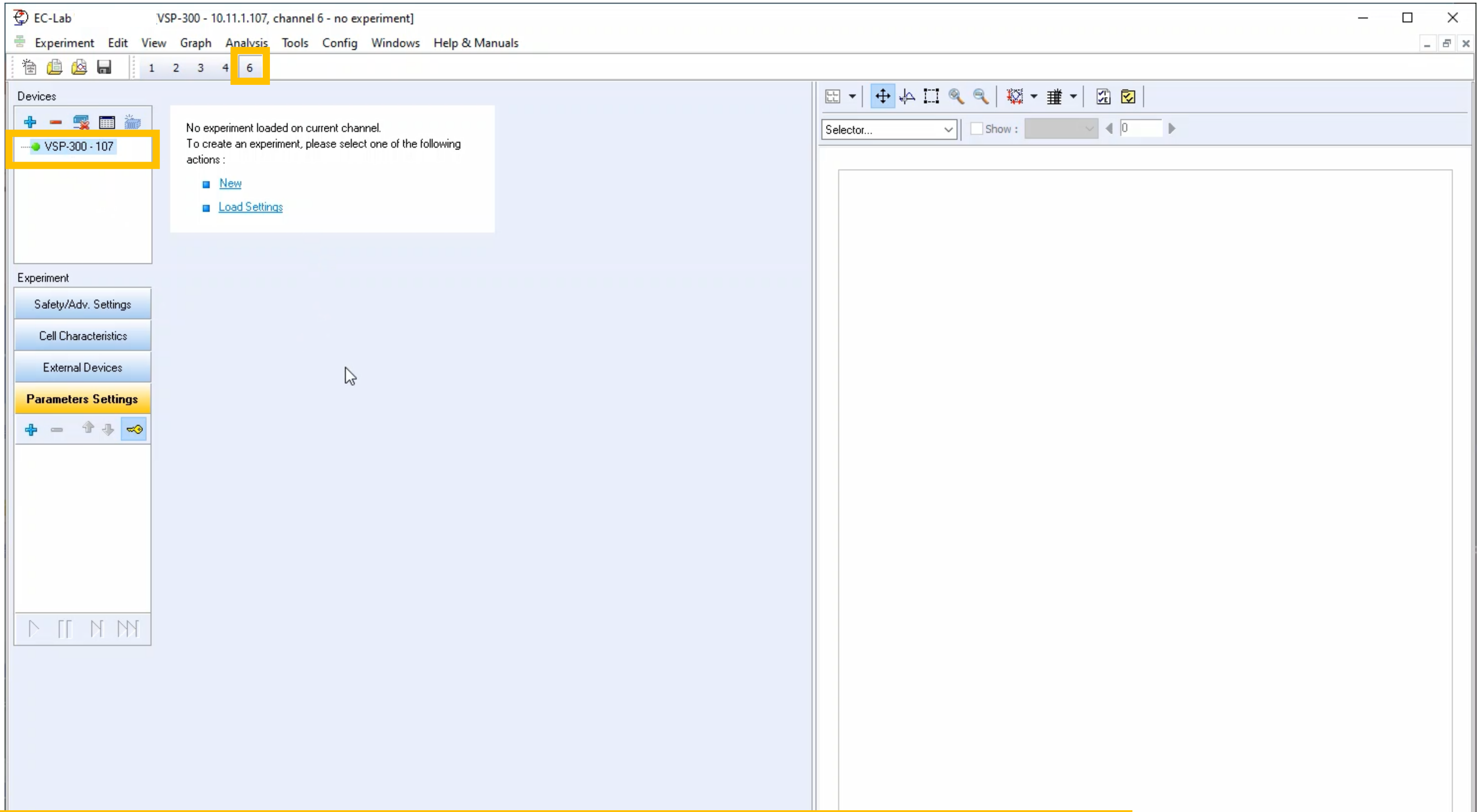
Note: Go back to this slide by clicking on the logo on the top left corner



Procedure

Step 0: Connect instrument and select channel

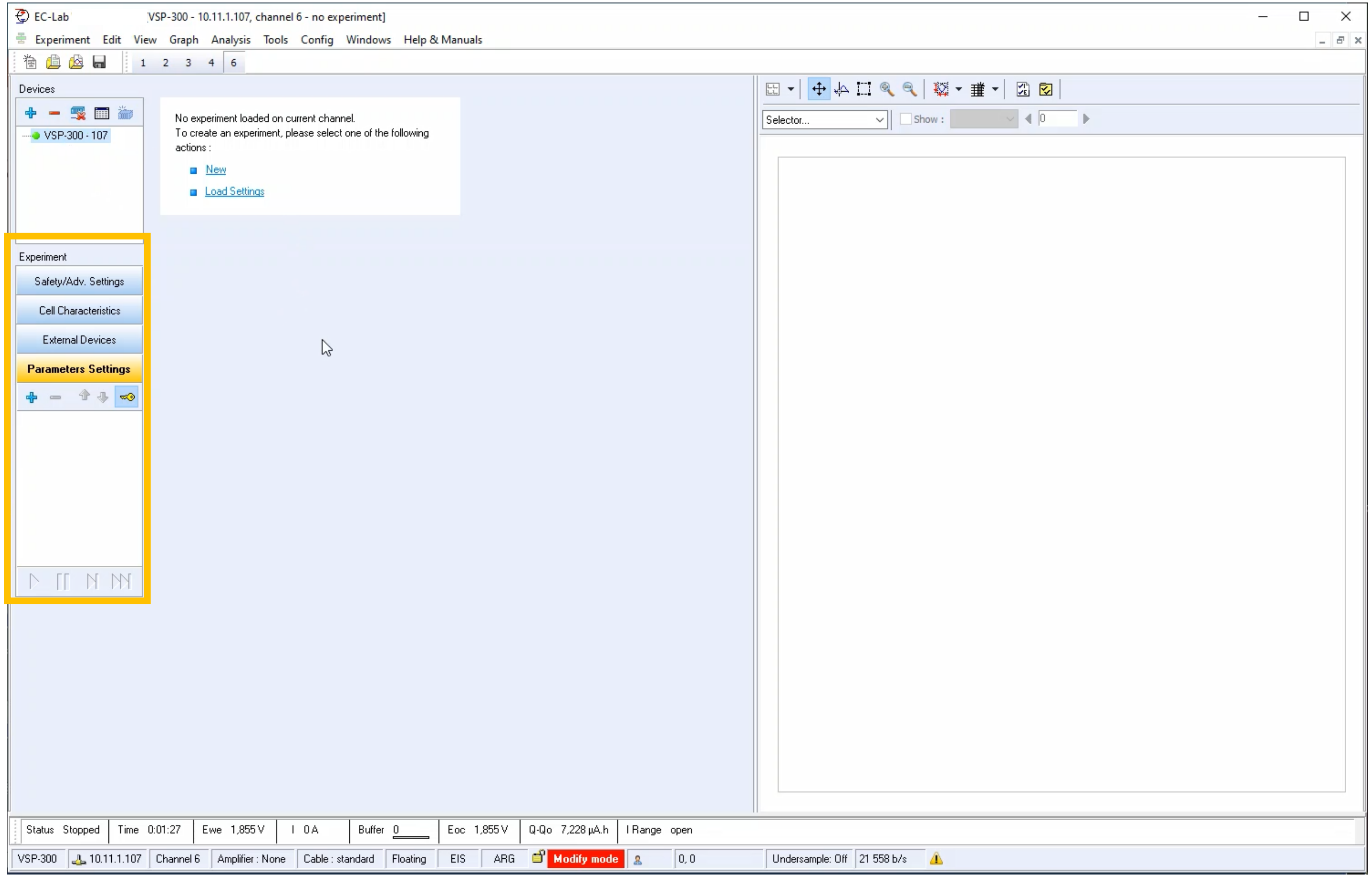
- Connect instrument and select channel



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

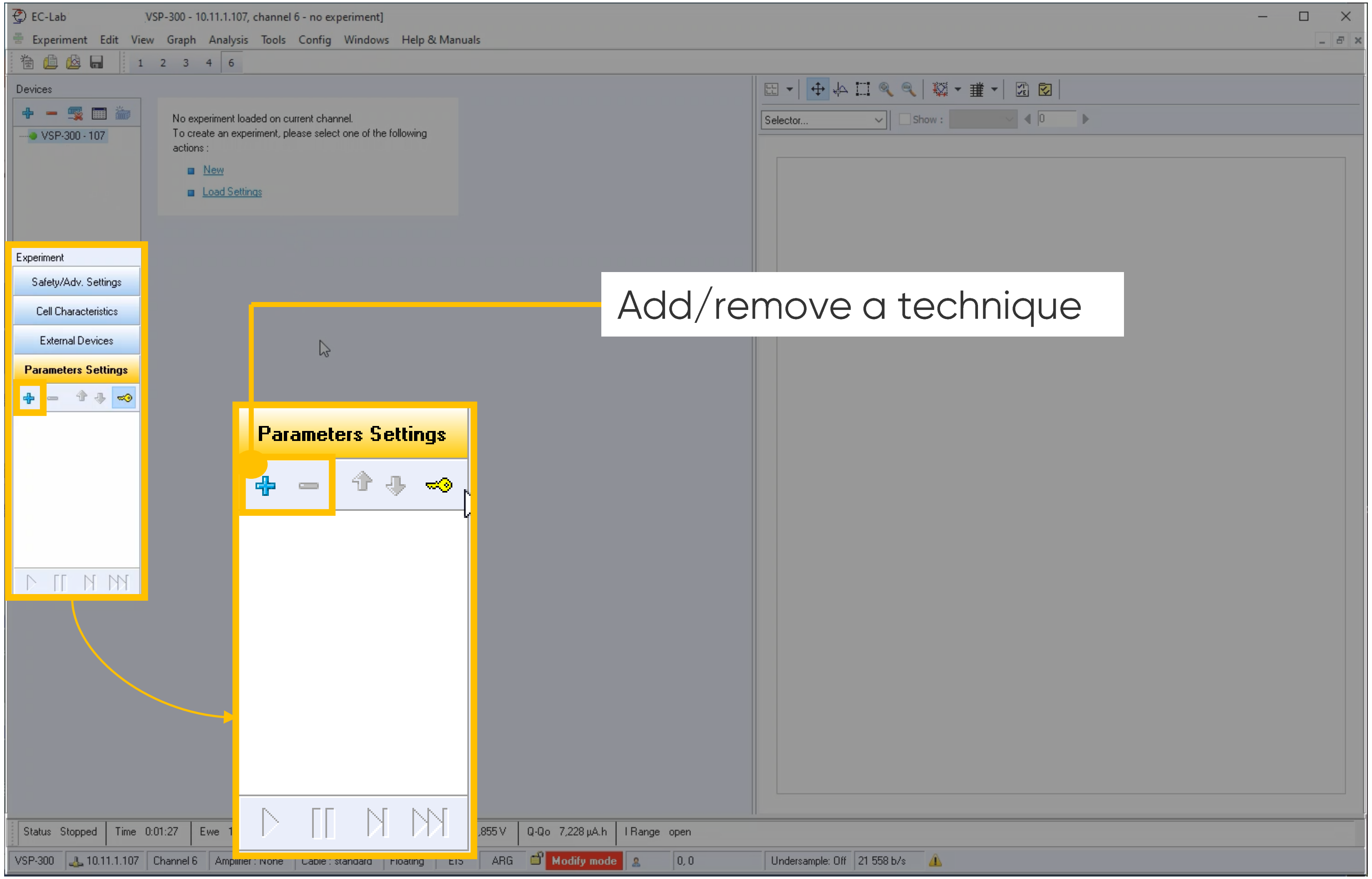
Step 0: Connect instrument and select channel

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



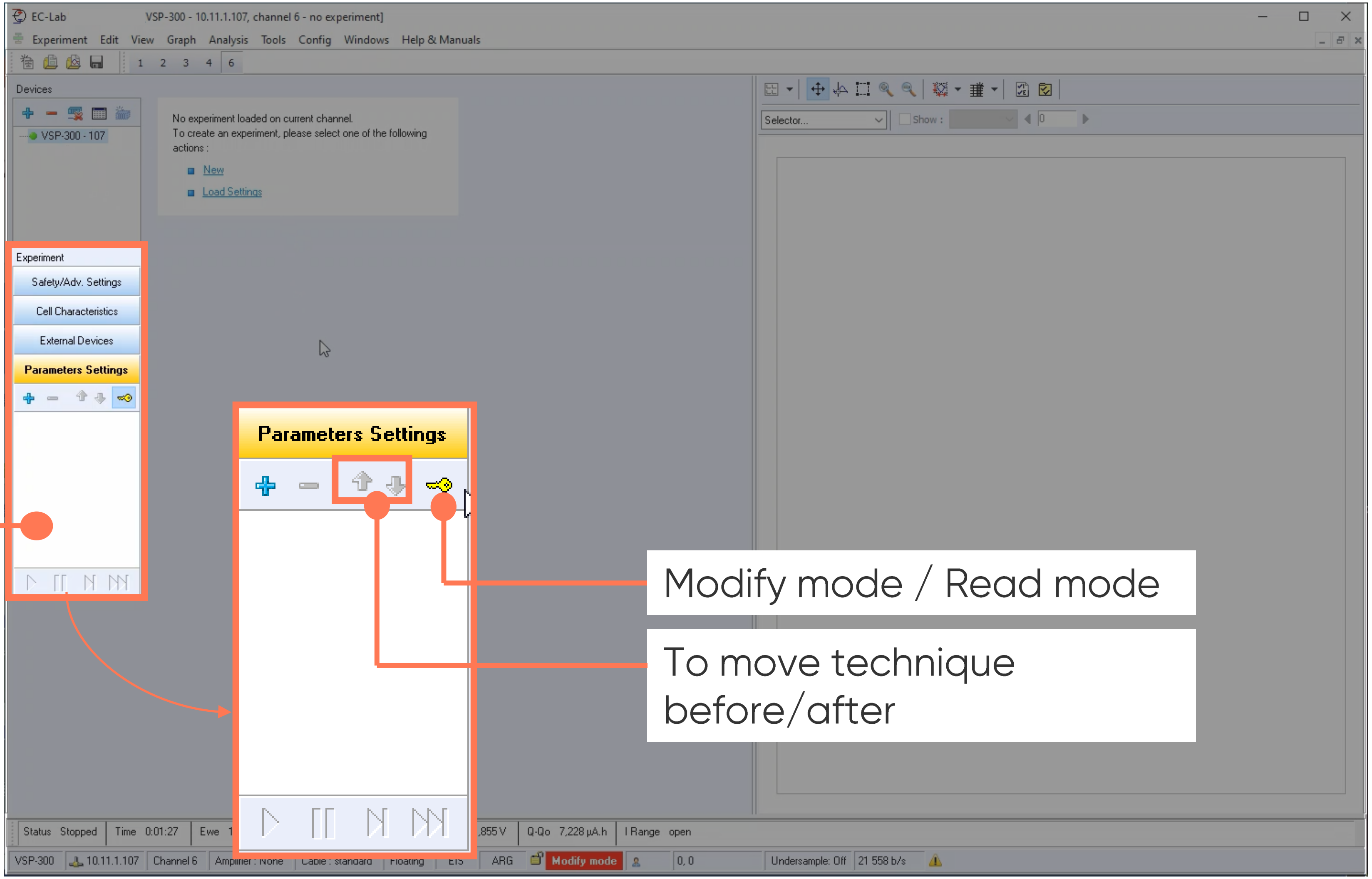
Step 1: Add Tafel Plot technique

- Click on + to add a technique in the list



Step 1: Add Tafel Plot technique

Empty window:
no loaded technique



Modify mode / Read mode

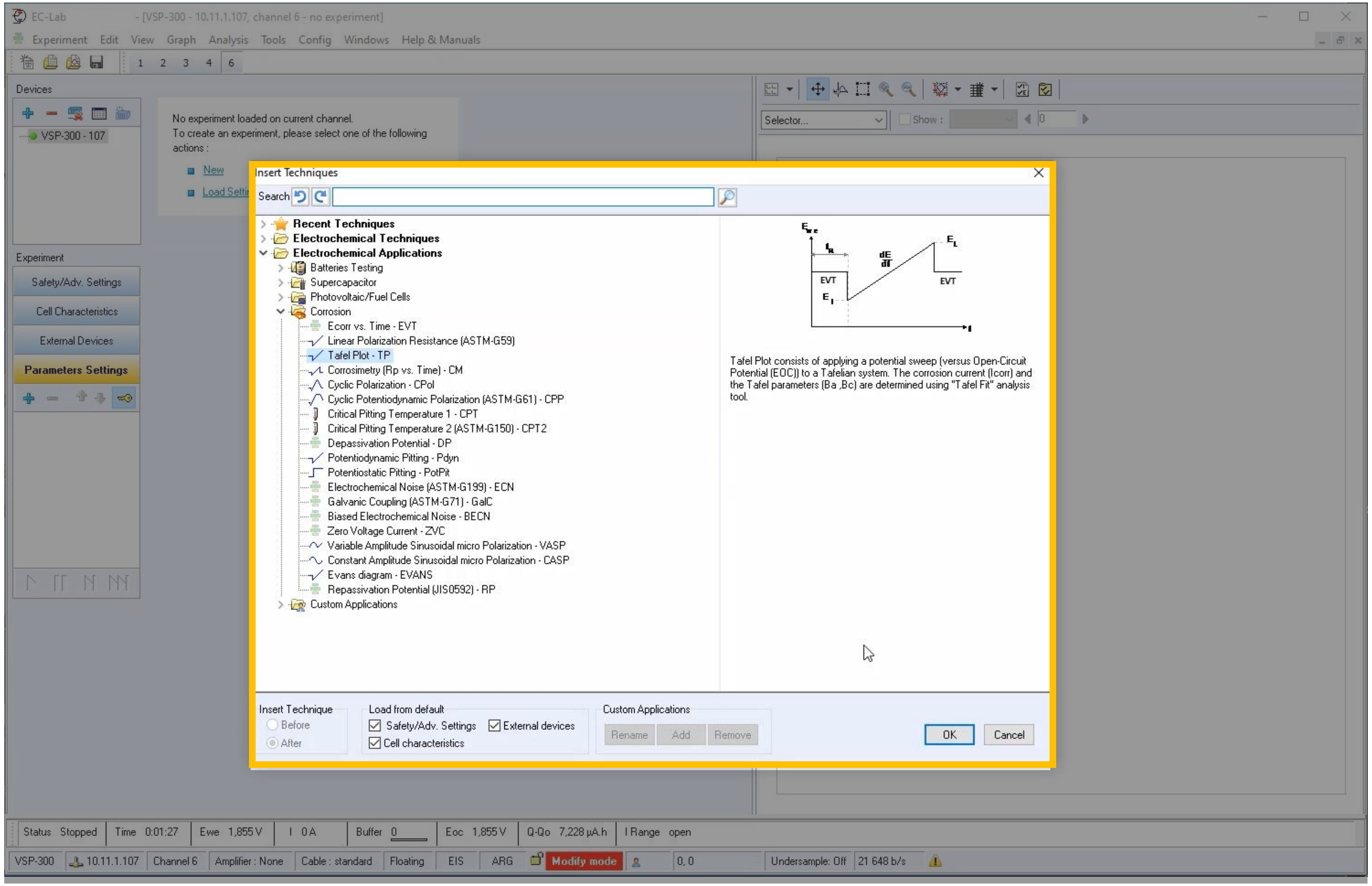
To move technique
before/after

Step 1: Add Tafel Plot technique

- Select Tafel plot technique

  It is in the Corrosion folder

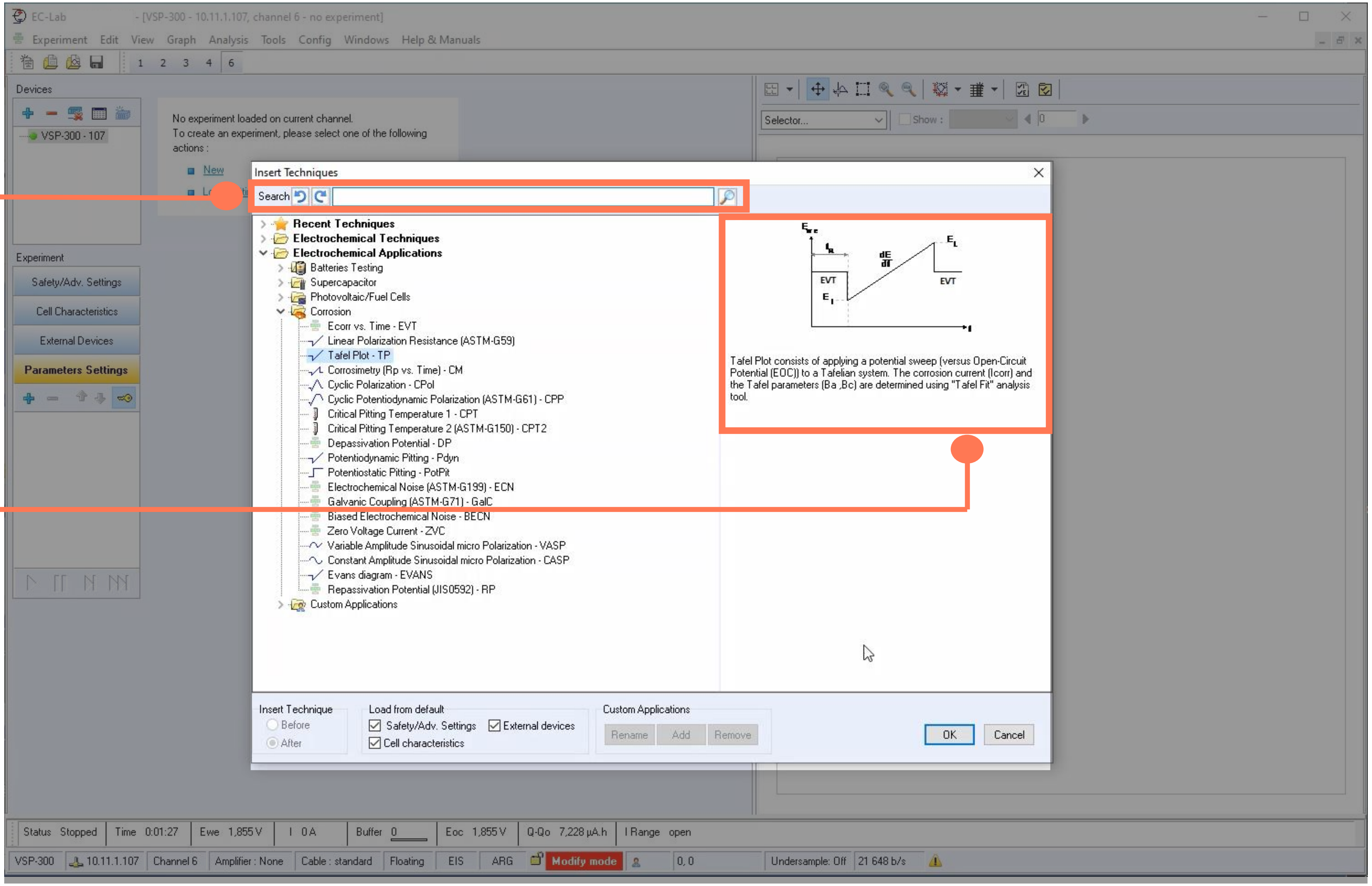
- Click on OK to validate



Step 1: Add Tafel Plot technique

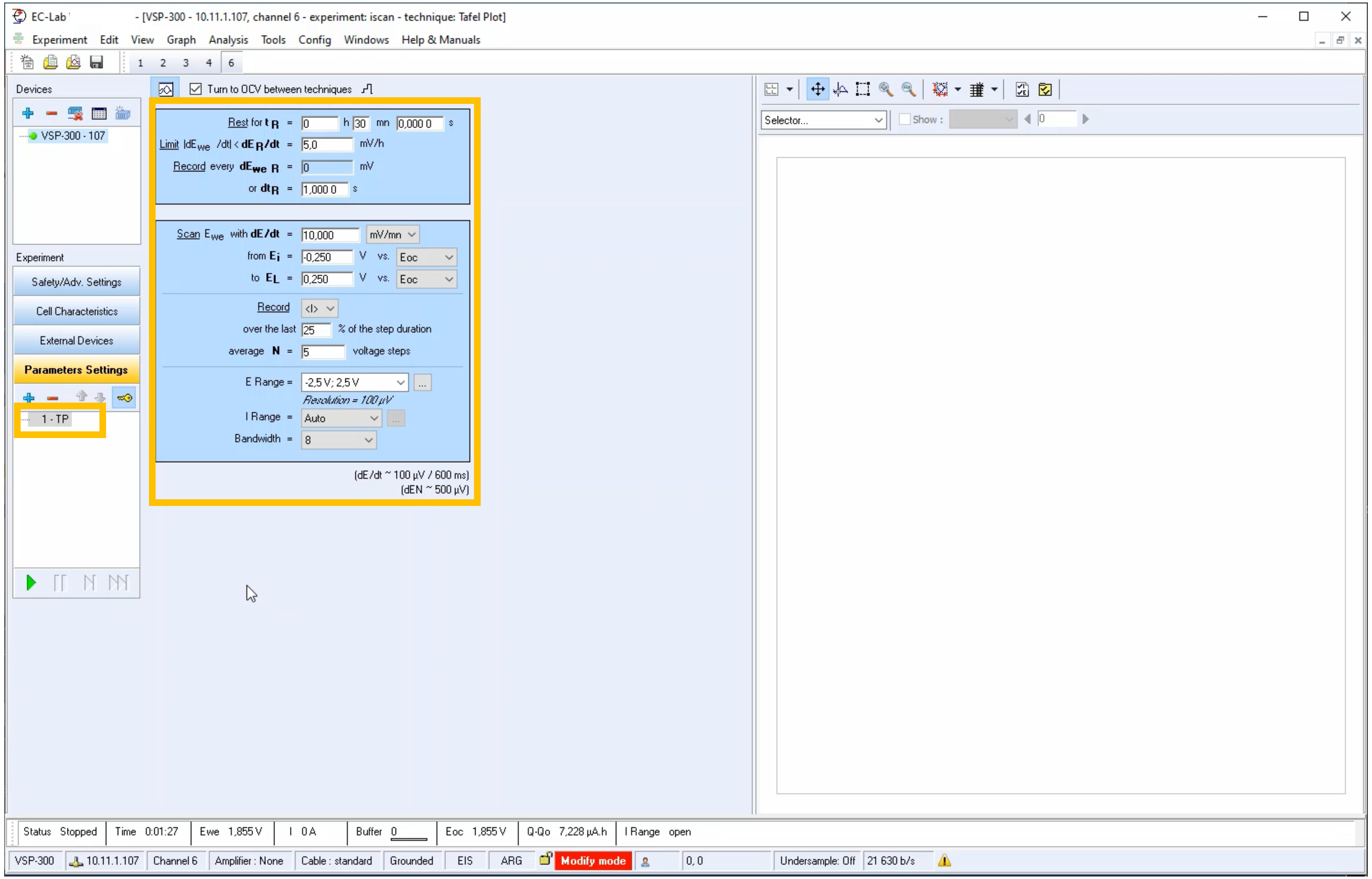
Search bar to quickly find the desired technique

Description of the settings technique and associated graph



Step 1: Add Tafel Plot technique

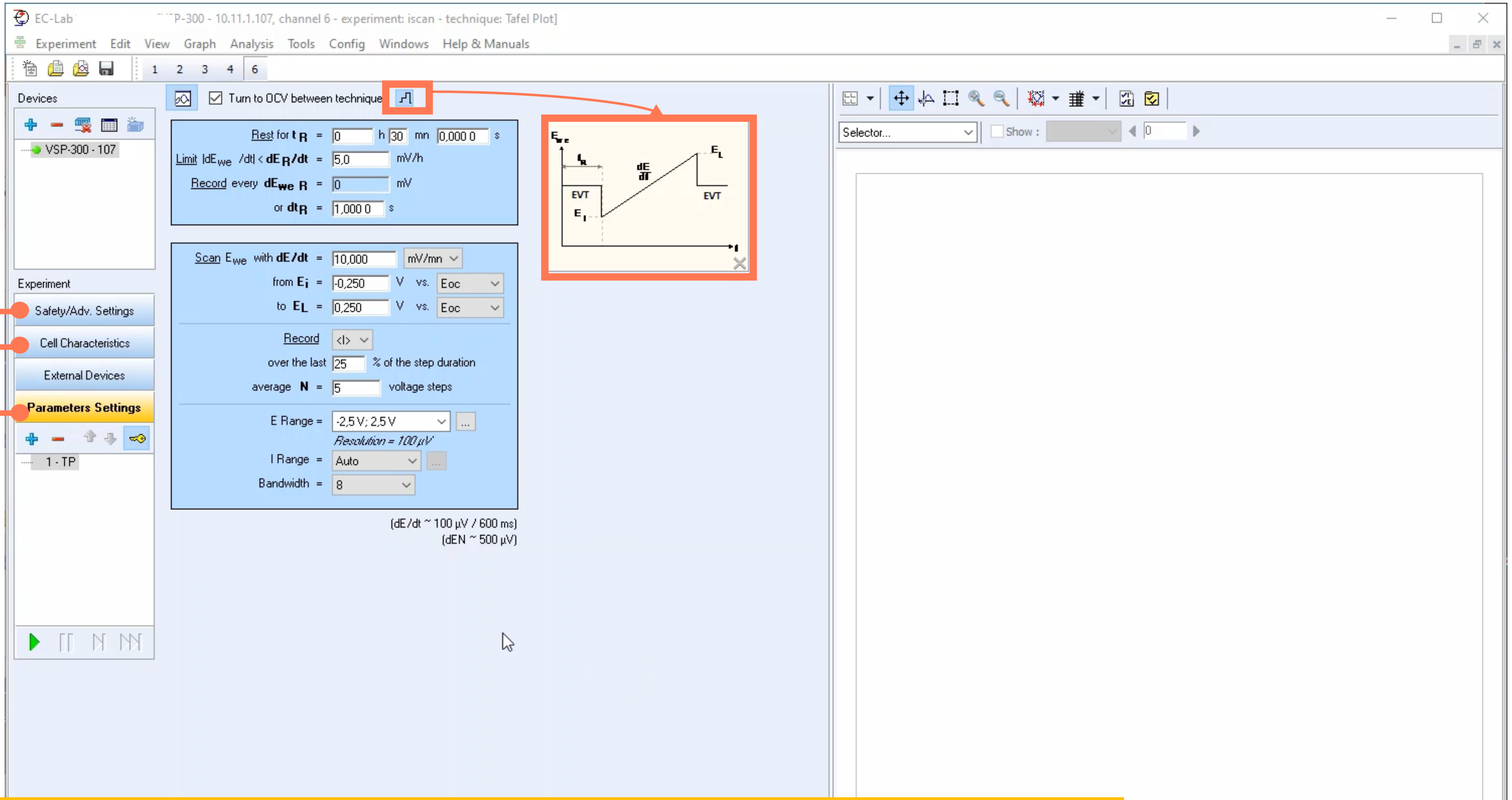
- Tafel Plot technique is loaded in the technique list
- Corresponding Tafel Plot parameter settings appear



Step 1: Add Tafel Plot technique

General parameters

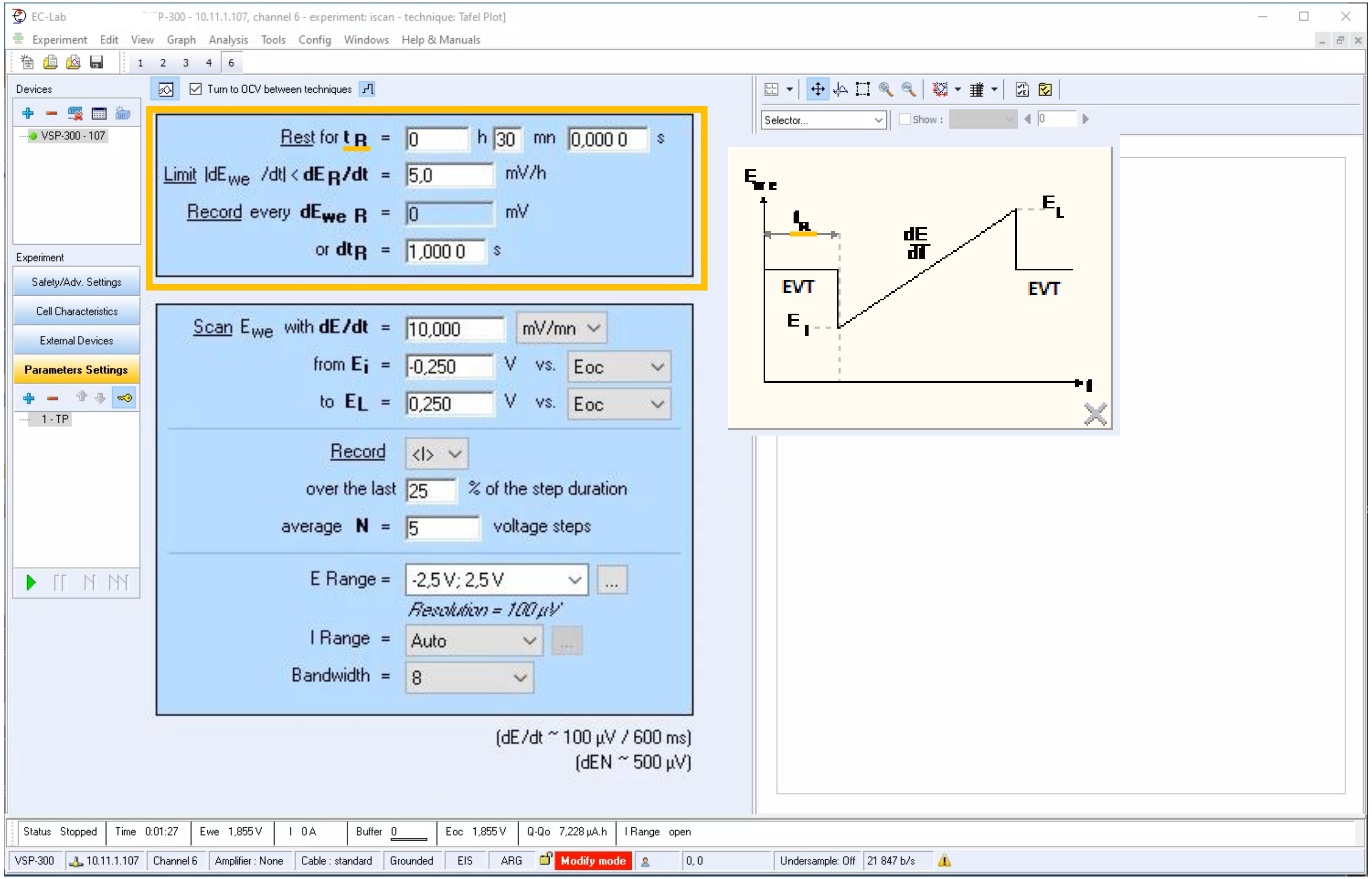
Technique parameters



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

Step 2: Set Tafel Plot parameters

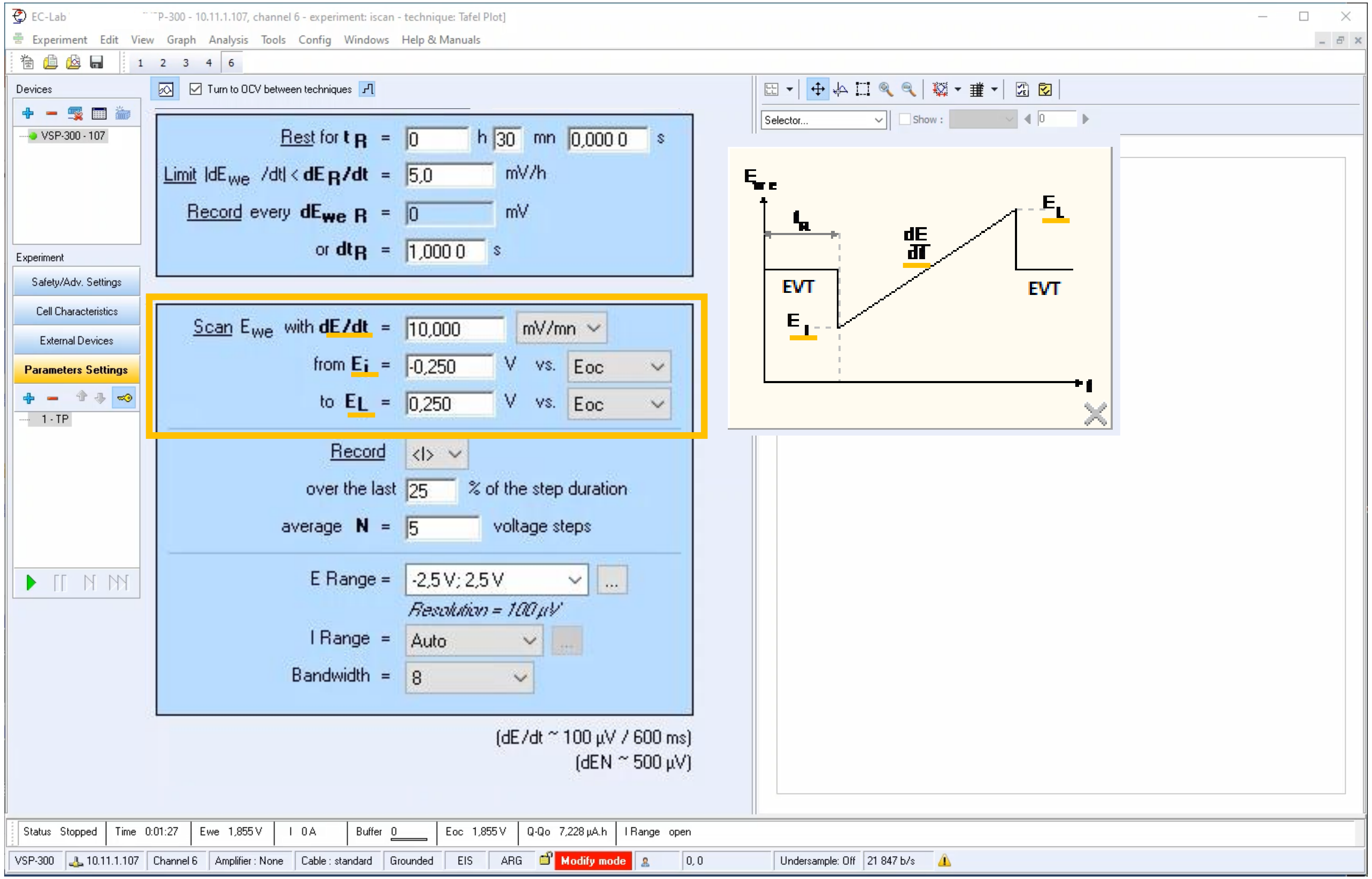
- Set t_R to obtain EVT



Note: Set limit in time or until stabilization of voltage

Step 2: Set Tafel Plot parameters

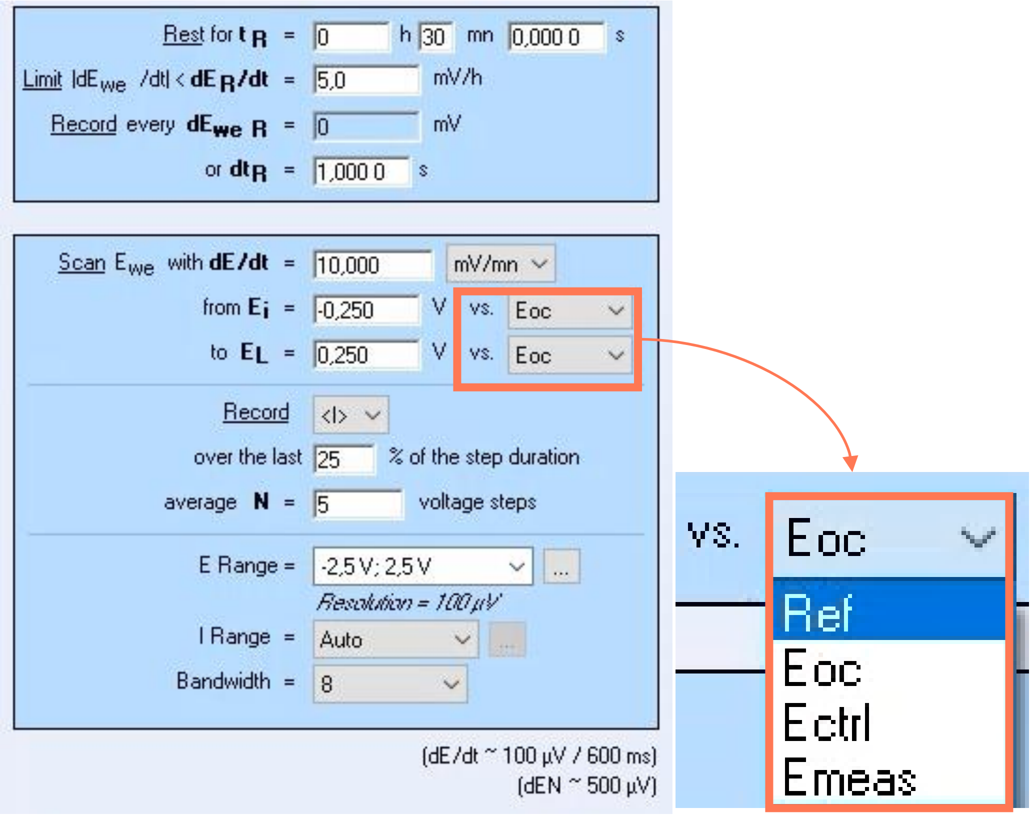
- Set E_i and E_L to define voltage ramp
- Set dE/dt to define voltage sweep



Step 2: Set Tafel Plot parameters

Define E_i, E_L versus voltage of:

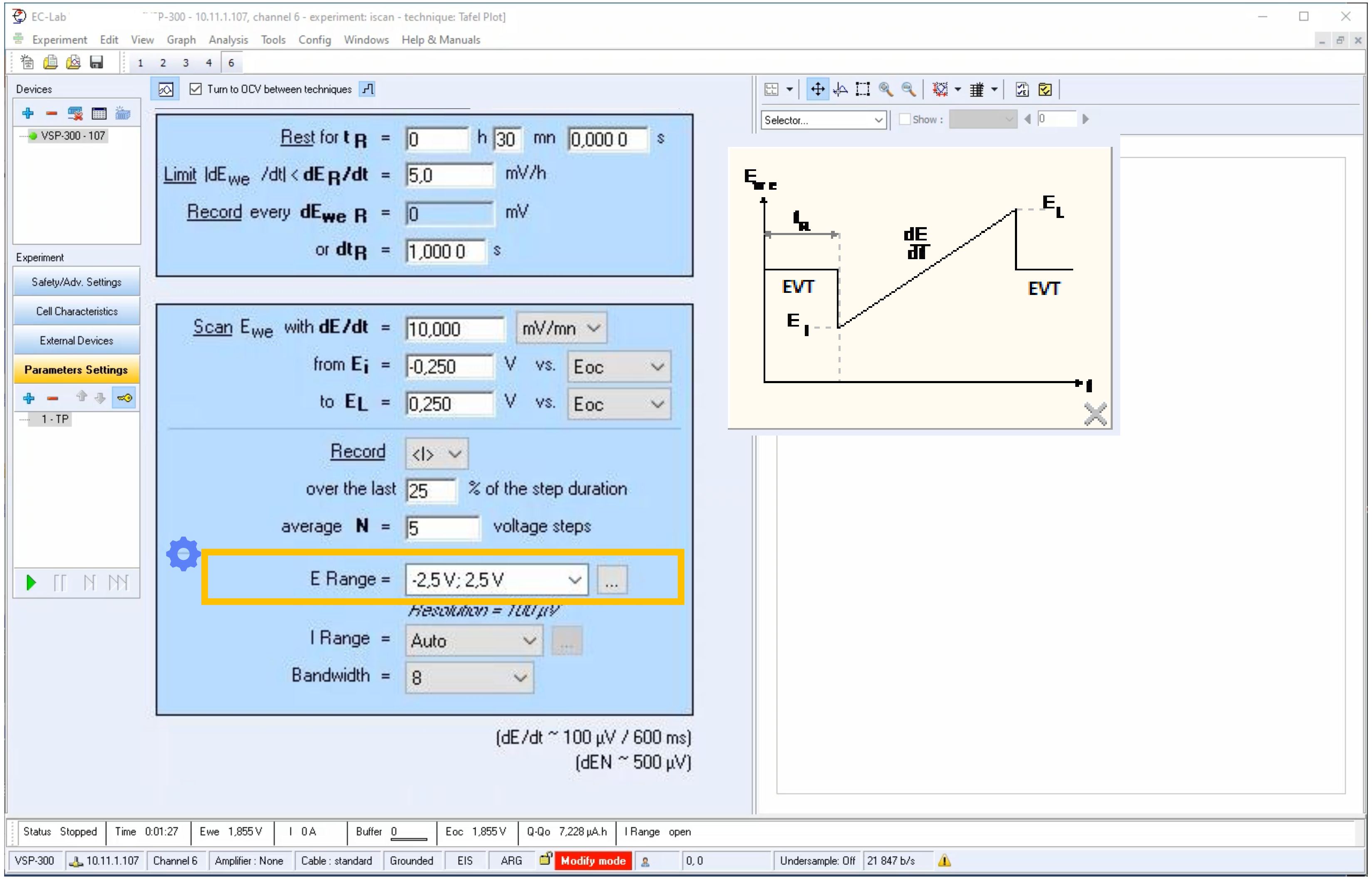
- **Ref:** the reference electrode
- **Eoc:** open circuit voltage
- **Ectrl:** the previous controlled voltage, if a technique is set before the Tafel plot
- **Emeas:** the previous measured voltage, if a technique is set before the Tafel plot



Set E_i and E_L vs. Eoc to polarize from corrosion potential (EVT).

Step 3: Optimize the measurement

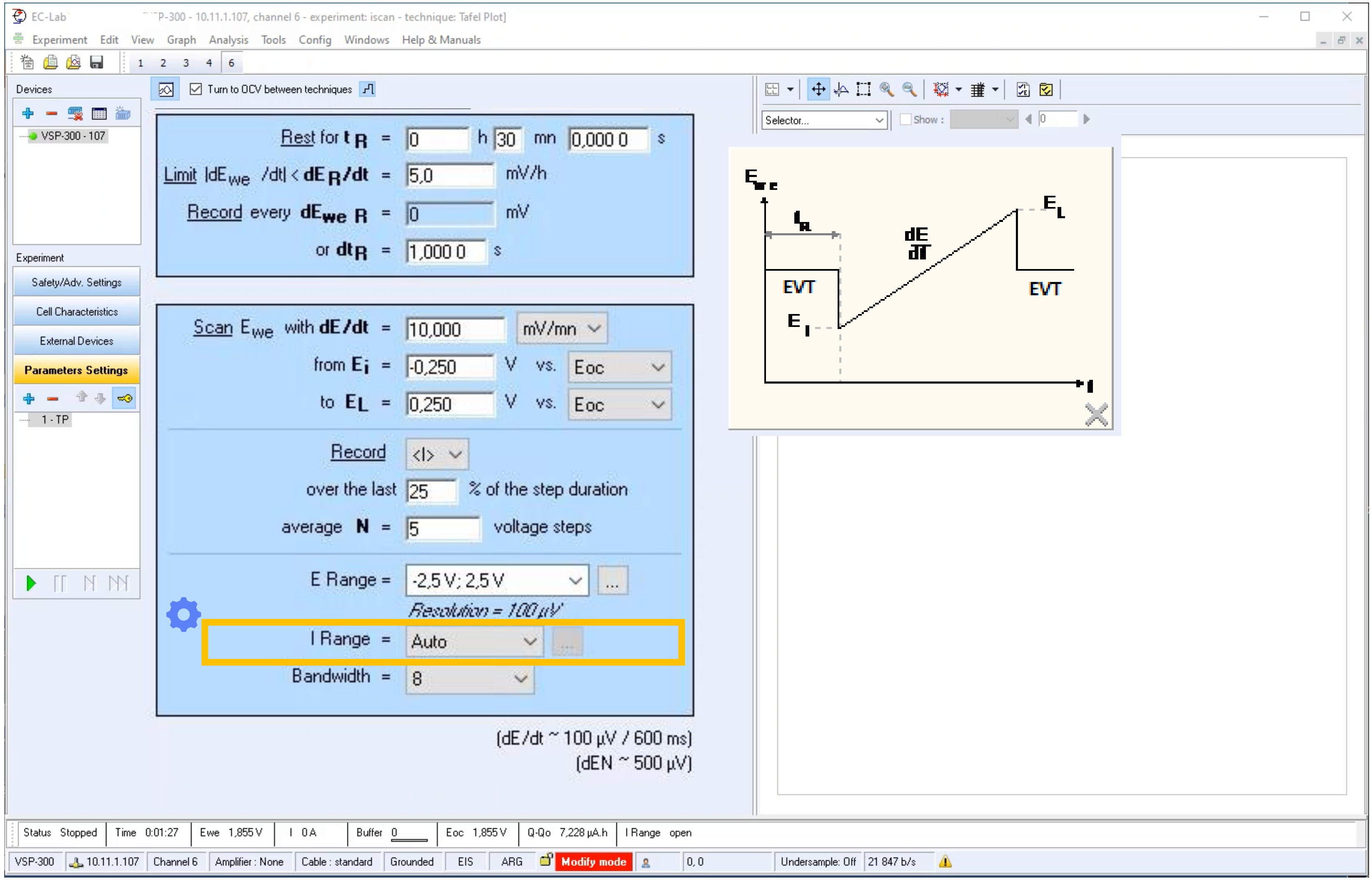
- E Range is the range of expected voltage
- E_i and E_L have to be in the E Range



E Range has to be as narrow as possible, the resolution depends on it.

Step 3: Optimize the measurement

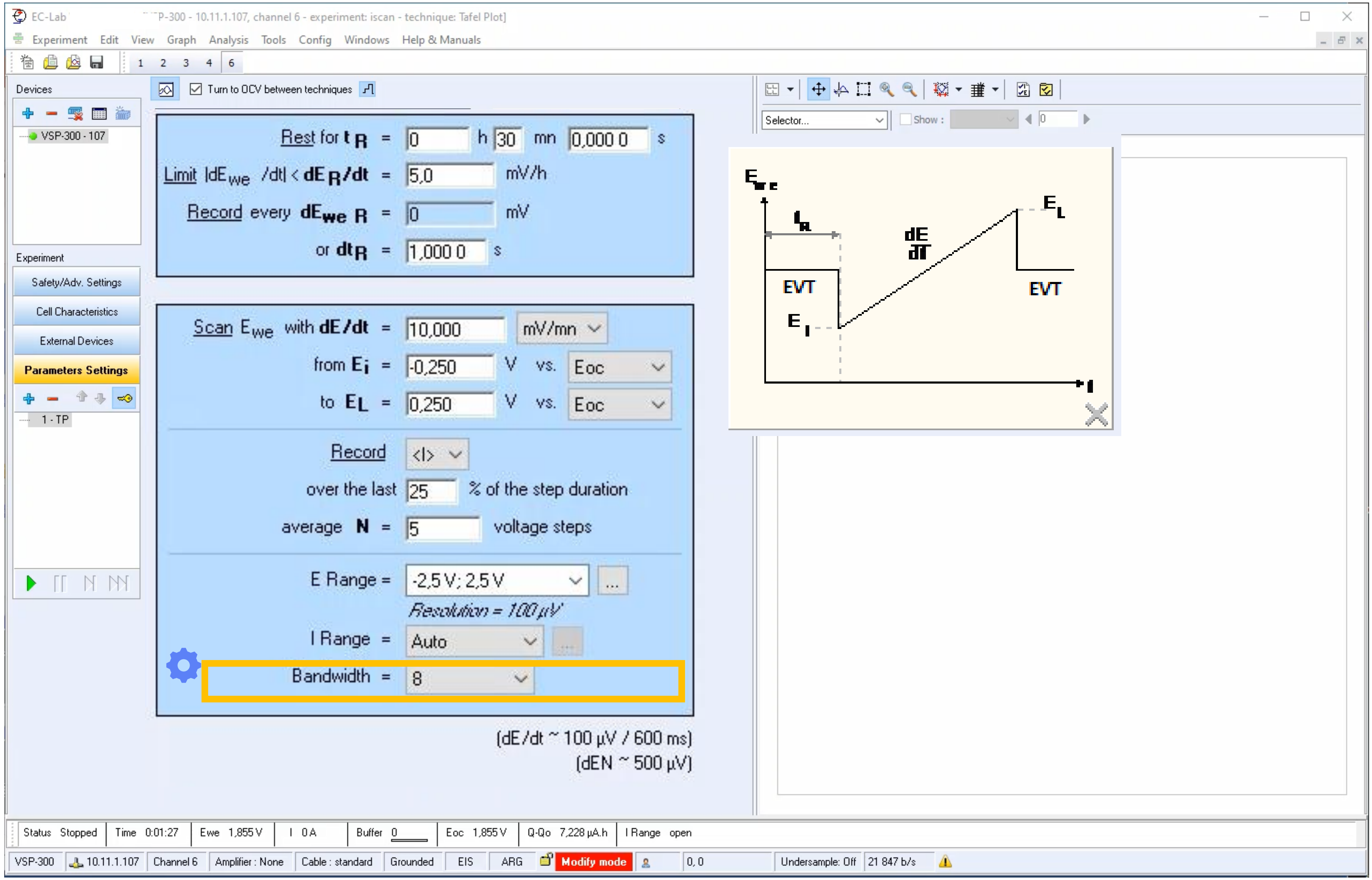
- I Range is the range of expected current
- Autorange is available



Autorange is recommanded when current range is unknowned.

Step 3: Optimize the measurement

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

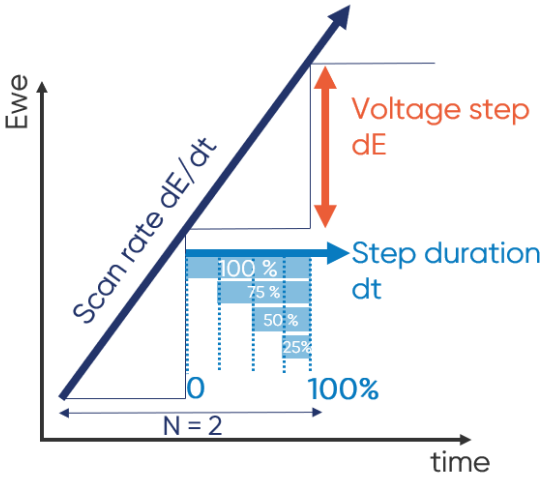


Set medium bandwidth to start

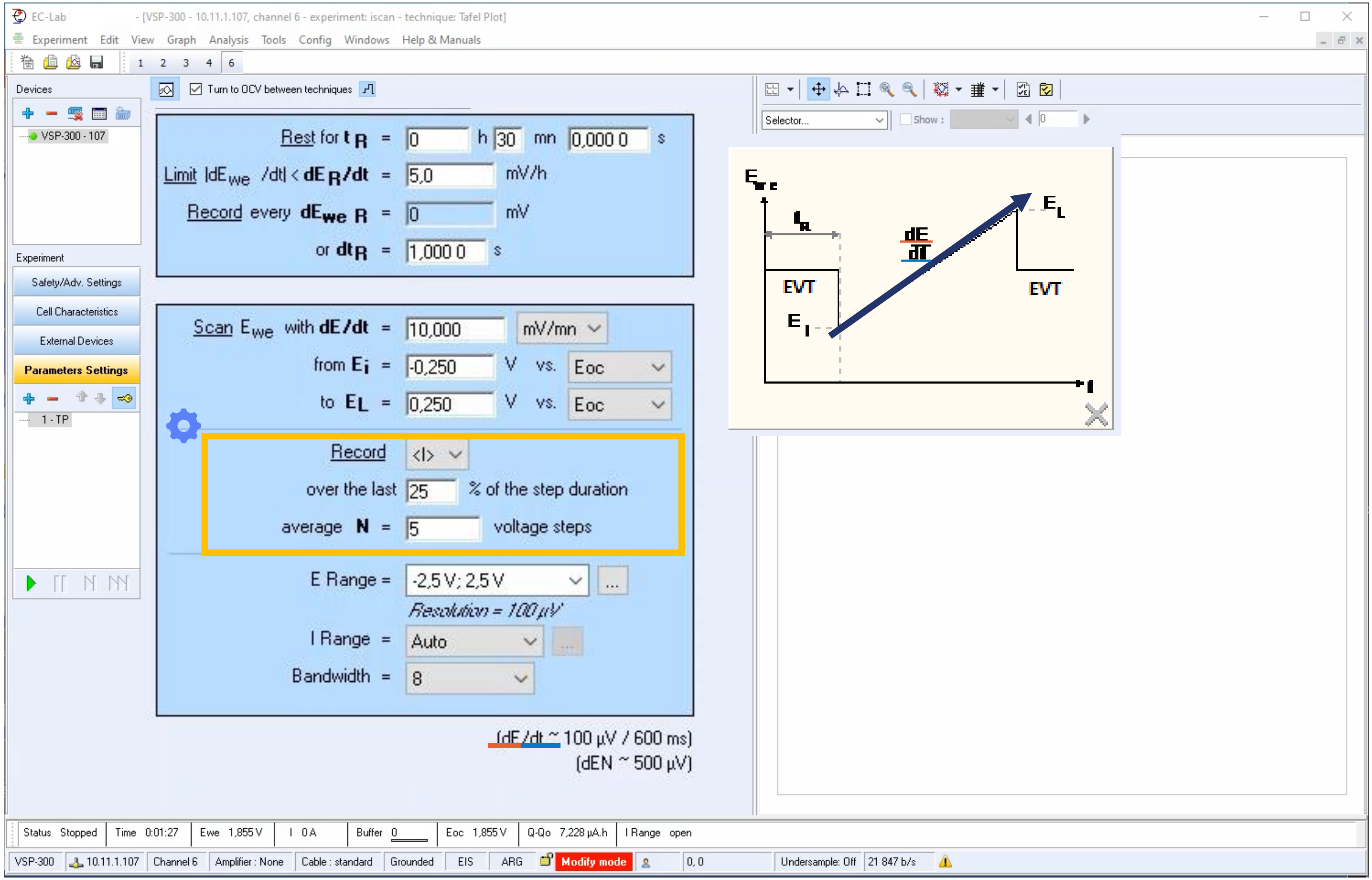
- 8-medium for essential
- 5-medium for premium

Step 3: Optimize the measurement

- Adjust current averaging and measurement



Note: dE is dependent on potential resolution

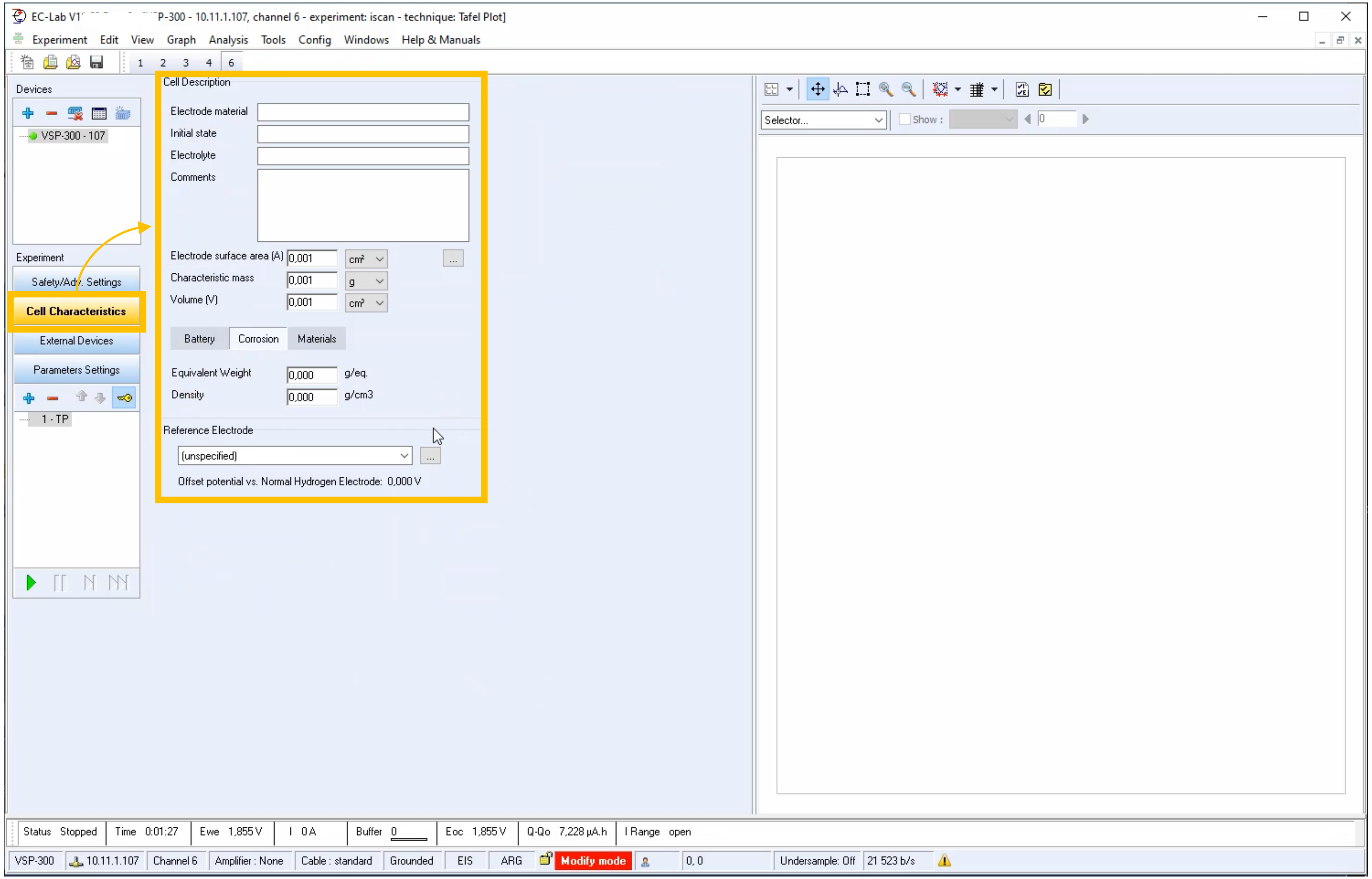


Set to 25% to cut first current value points and mainly measured Faradaic current.

N = 5 voltage steps allows to get smoother data

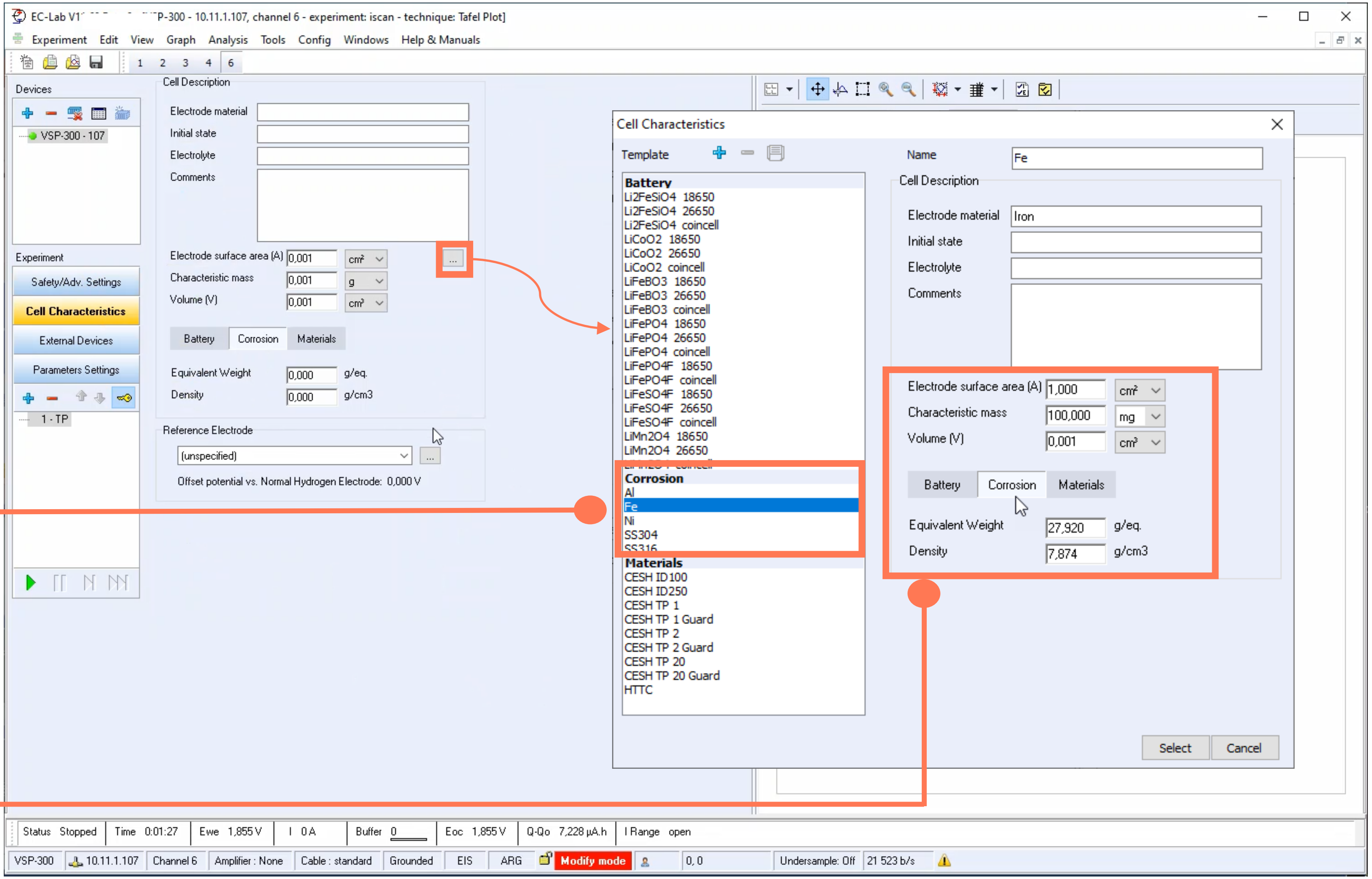
Step 4: Set general parameters

- Add information and comments about the cell



Note: All this information is store in the data file

Step 4: Set general parameters

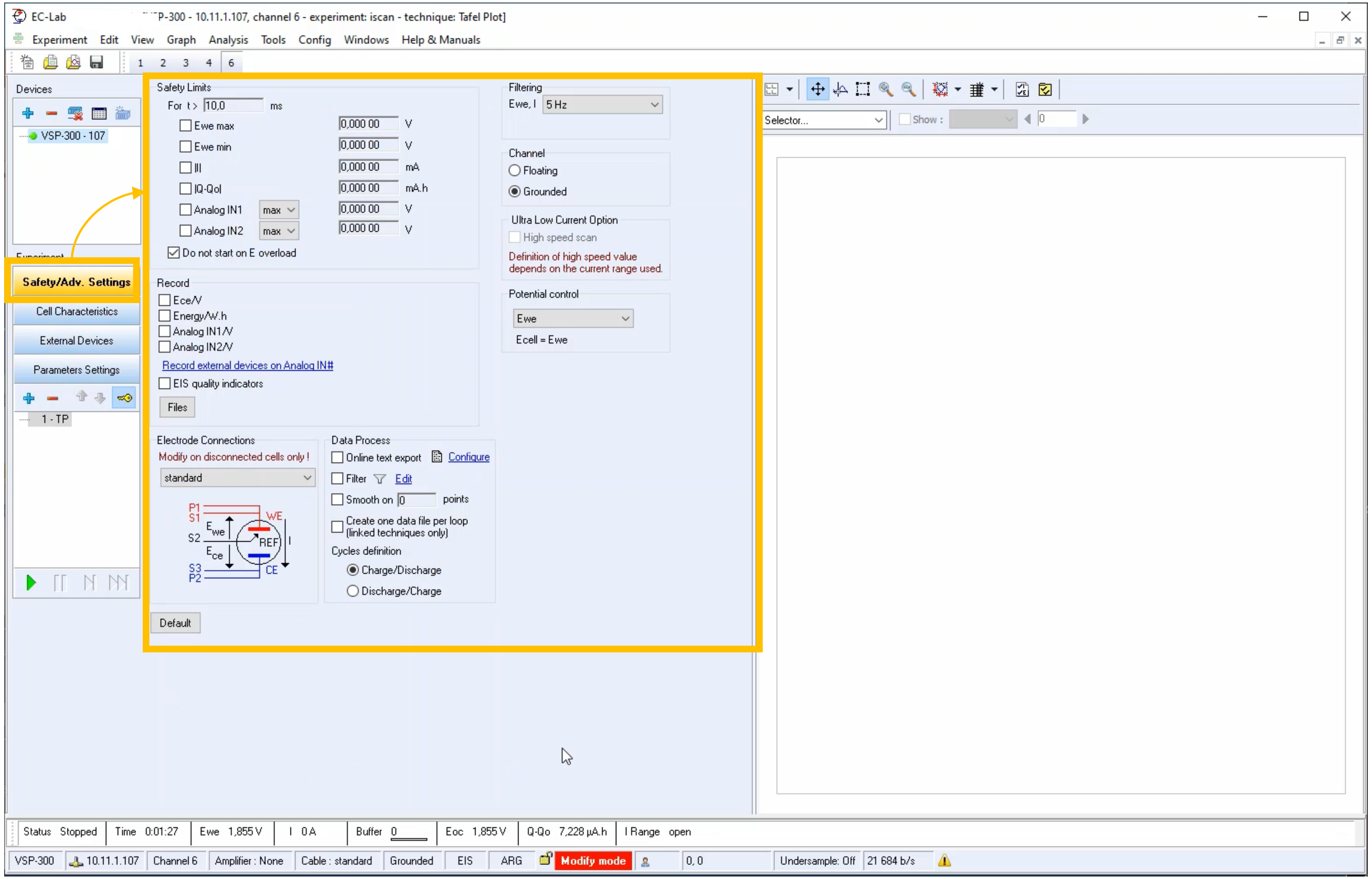


Dedicated corrosion section
(Save your sample characteristics in a template)

Values are used for Tafel fit analysis

Step 4: Set general parameters

- Safety and Advanced Settings are available here

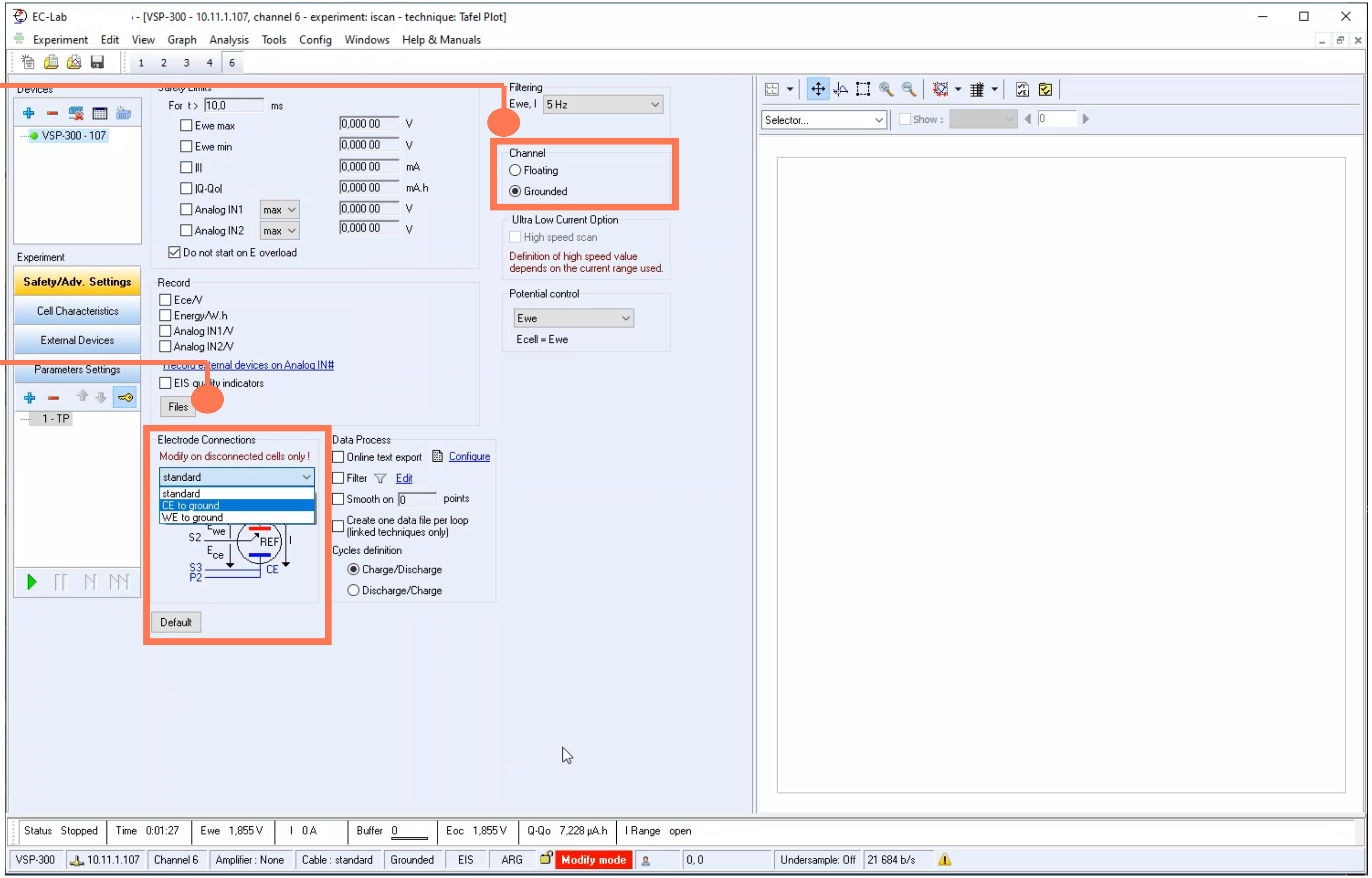


Note: This windows is different for the Essential and Premium instruments

Step 4: Set general parameters

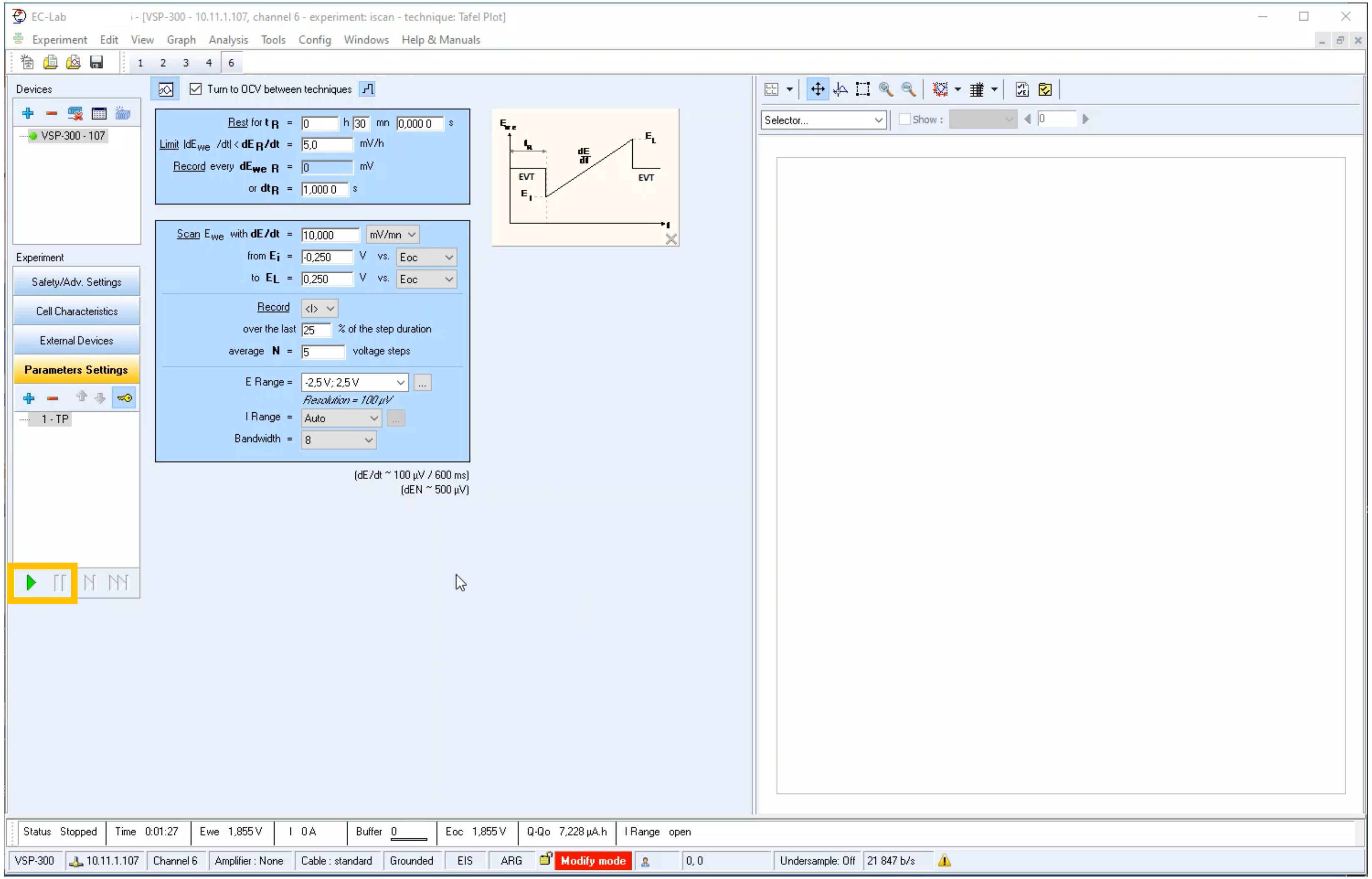
Floating connection
avoid ground loop
(only available for
Premium potentiostats)

CE to ground enable
multielectrode
experiments



Step 5: Launch the measurement

- Click on ▷ to launch experiment

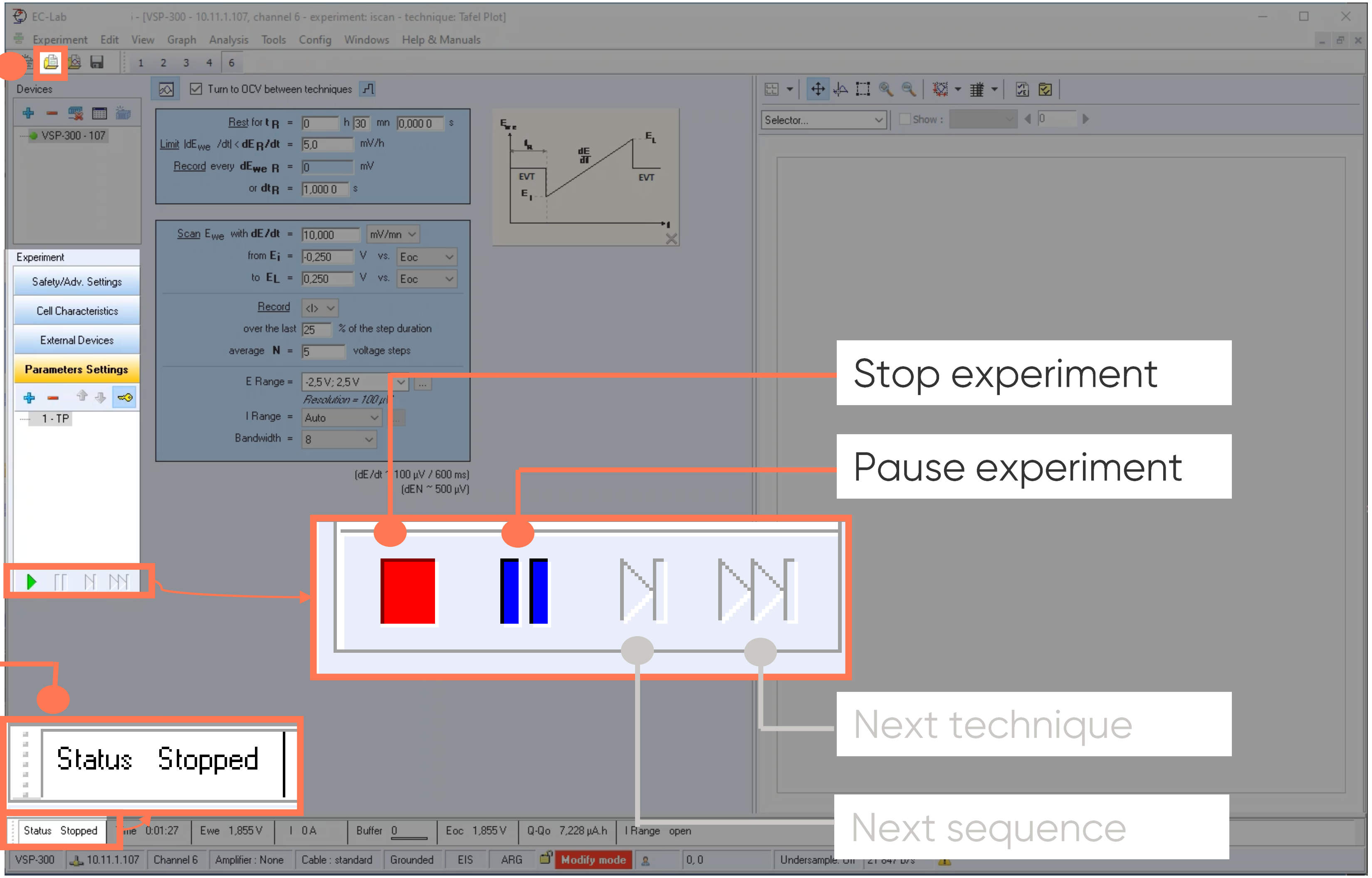


Note: All the settings may be changed during the experiment (Modify on the fly) except Irange, Erange and bandwidth

Step 5: Launch the measurement

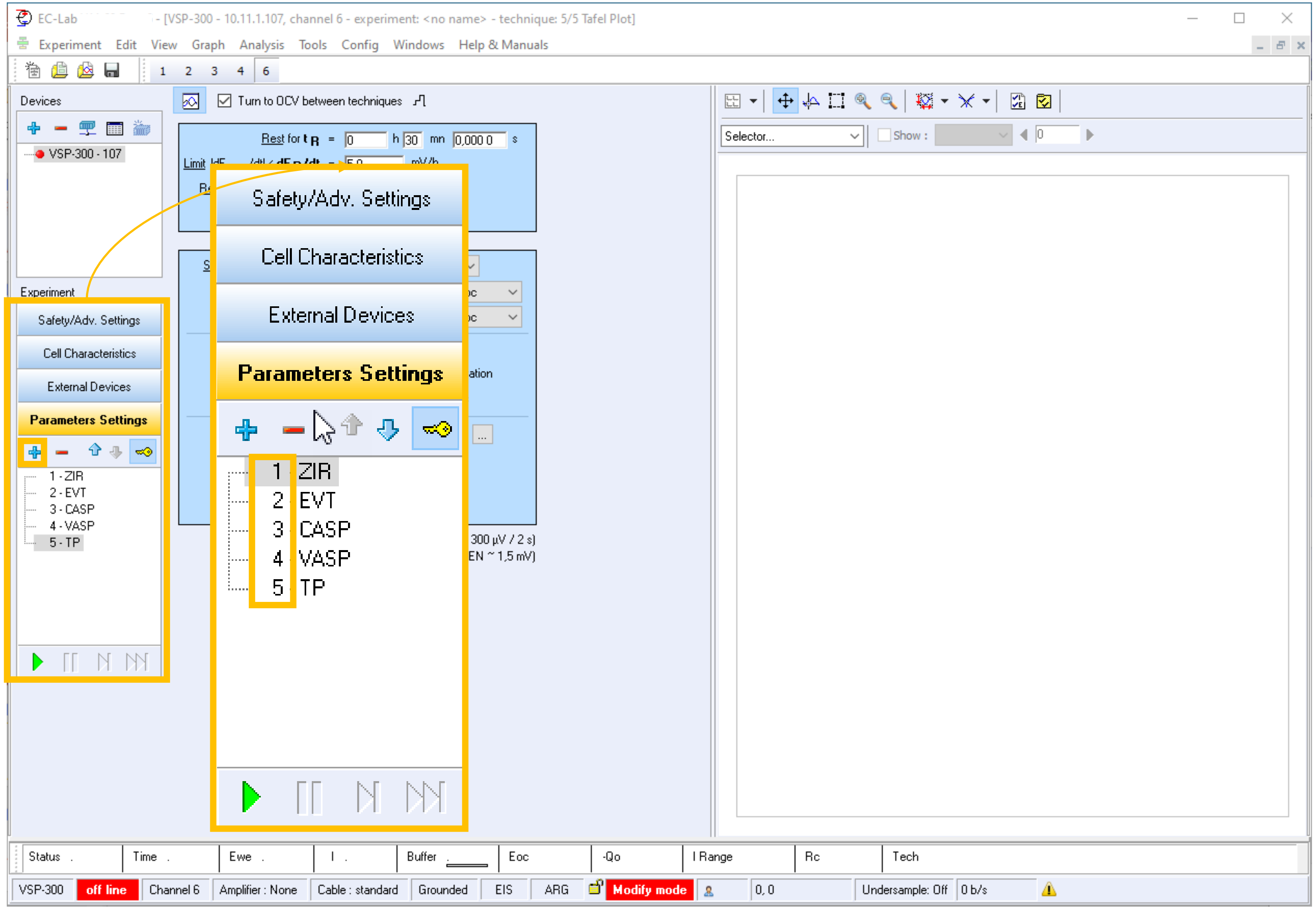
Load techniques with same settings using a .mps file created when launching the experiment

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

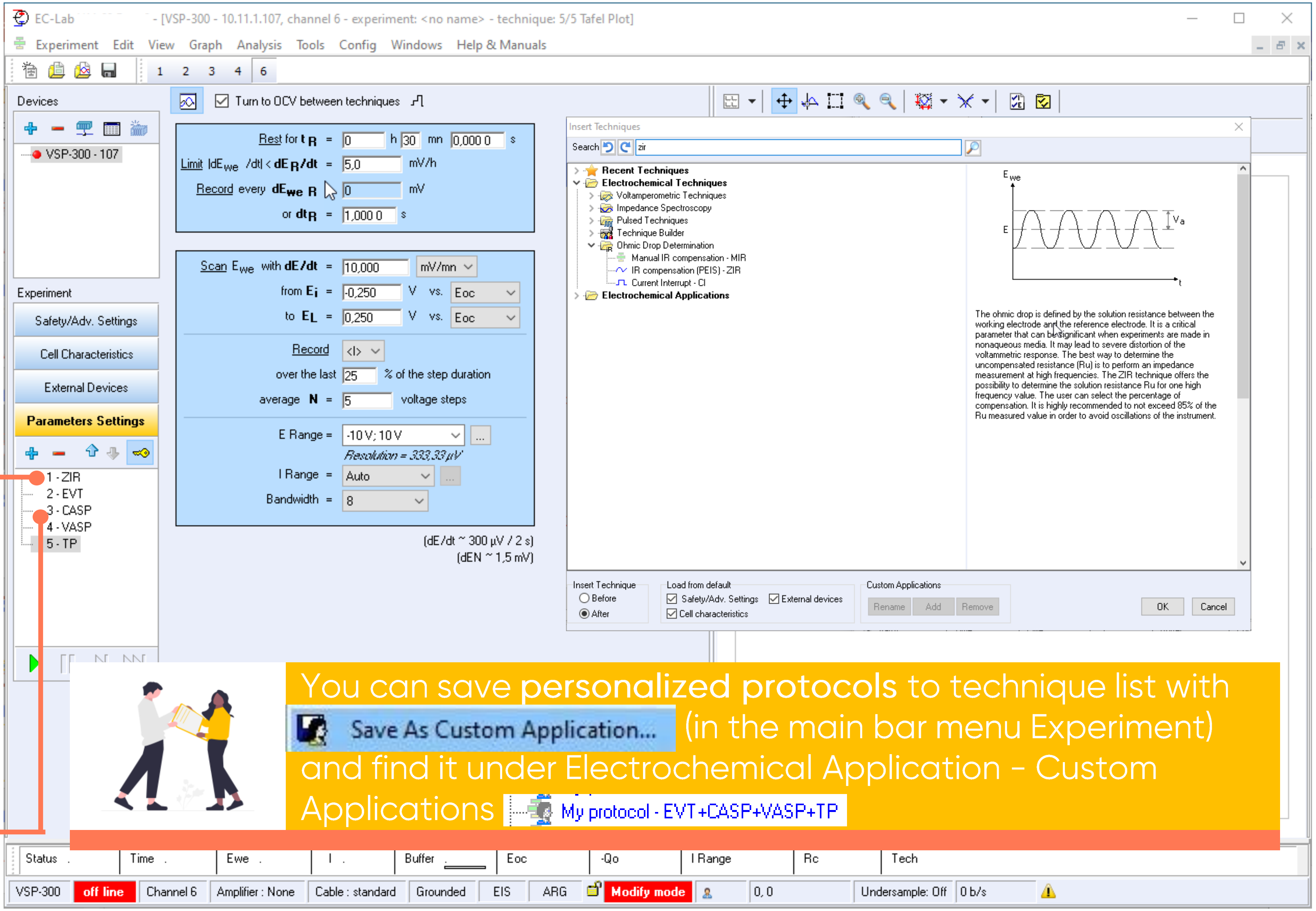


Step 6: Add additional experiments

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



Step 6: Add additional experiments



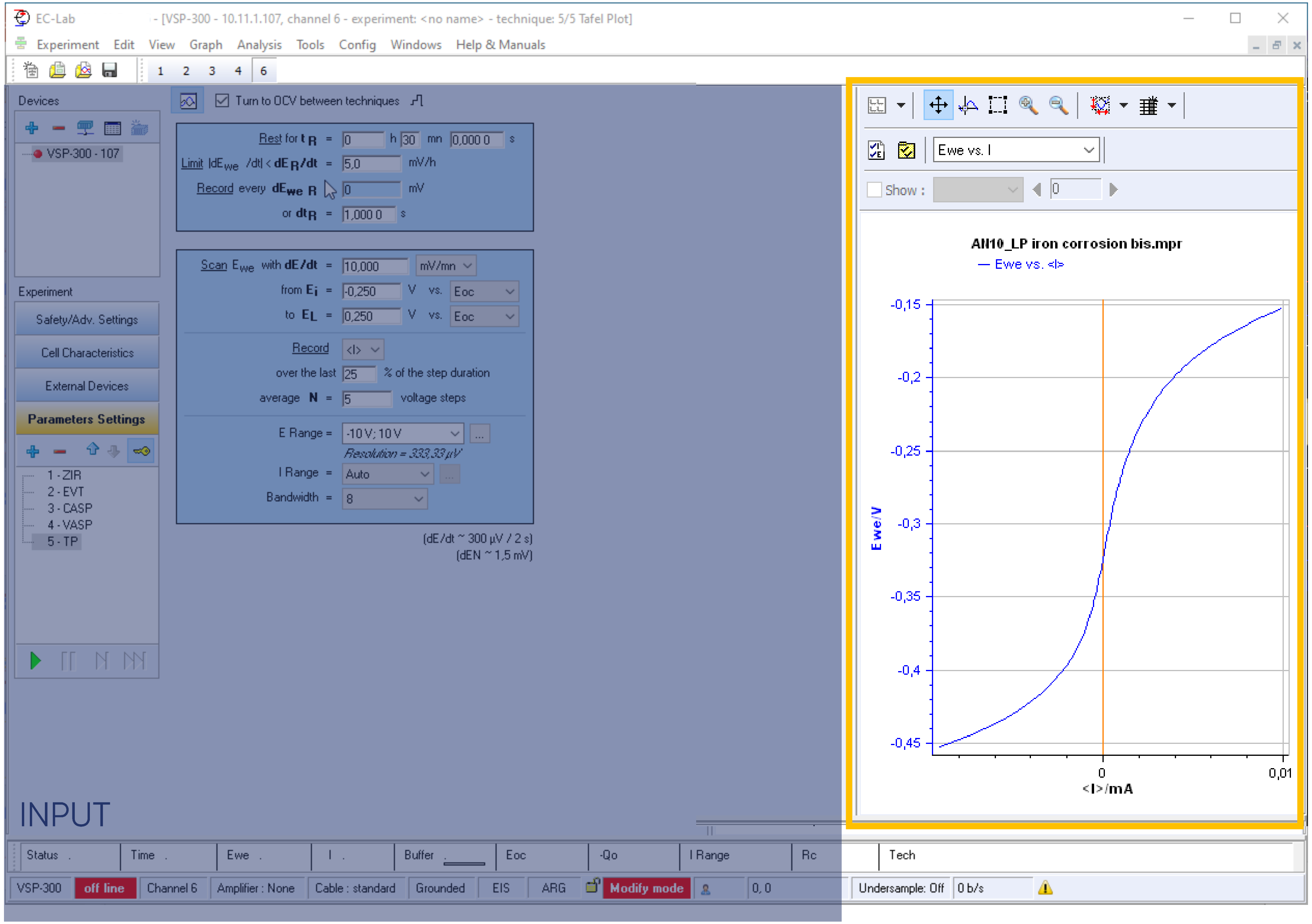
Can be used to determine and compensate ohmic drop

Impedance techniques must be performed before Tafel Plot

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 - EVT+CASP+VASP+TP**

Step 7: Read the graph

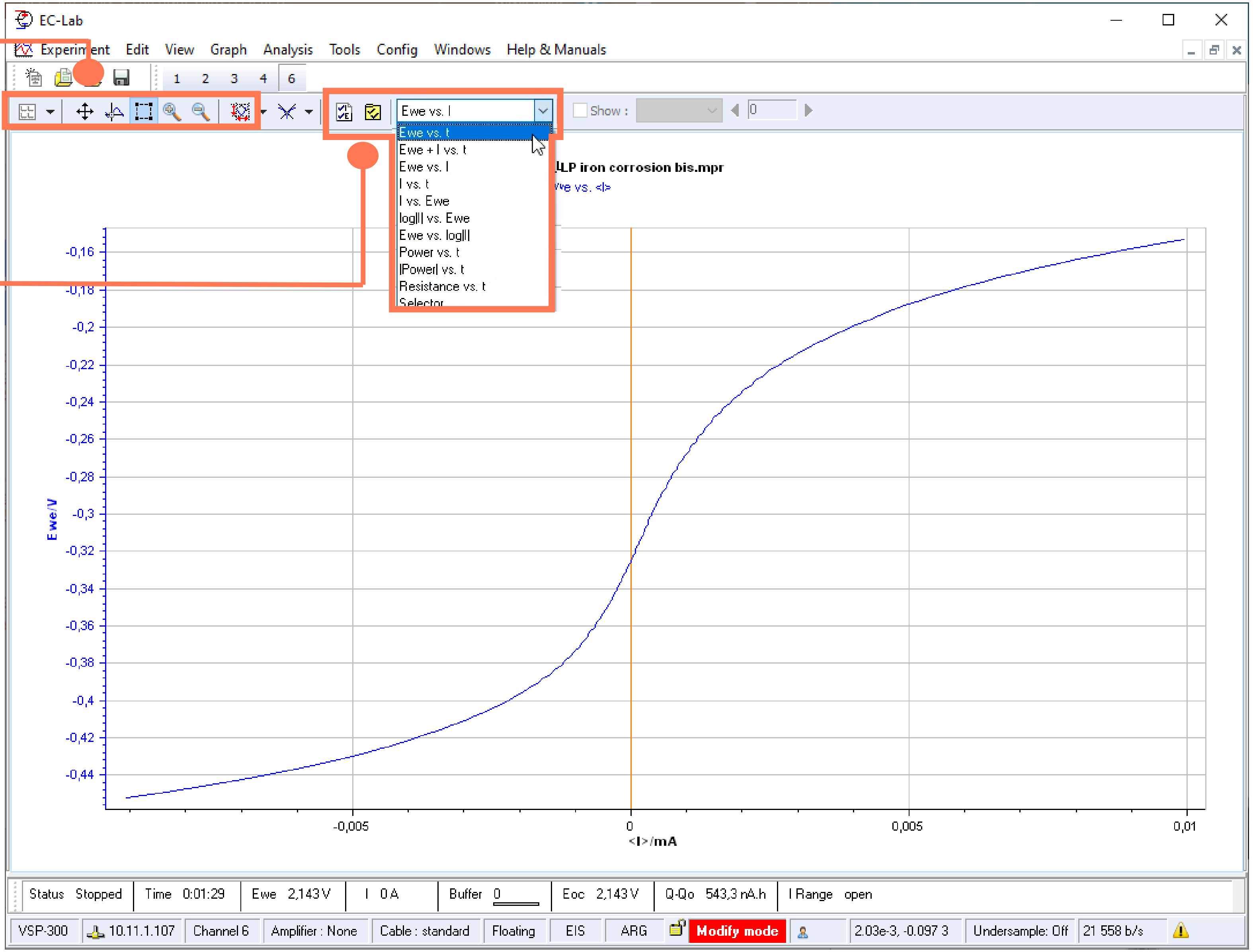
- Graphic is displayed in real time
- Data are saved in .mpr file



Step 7: Read the graph

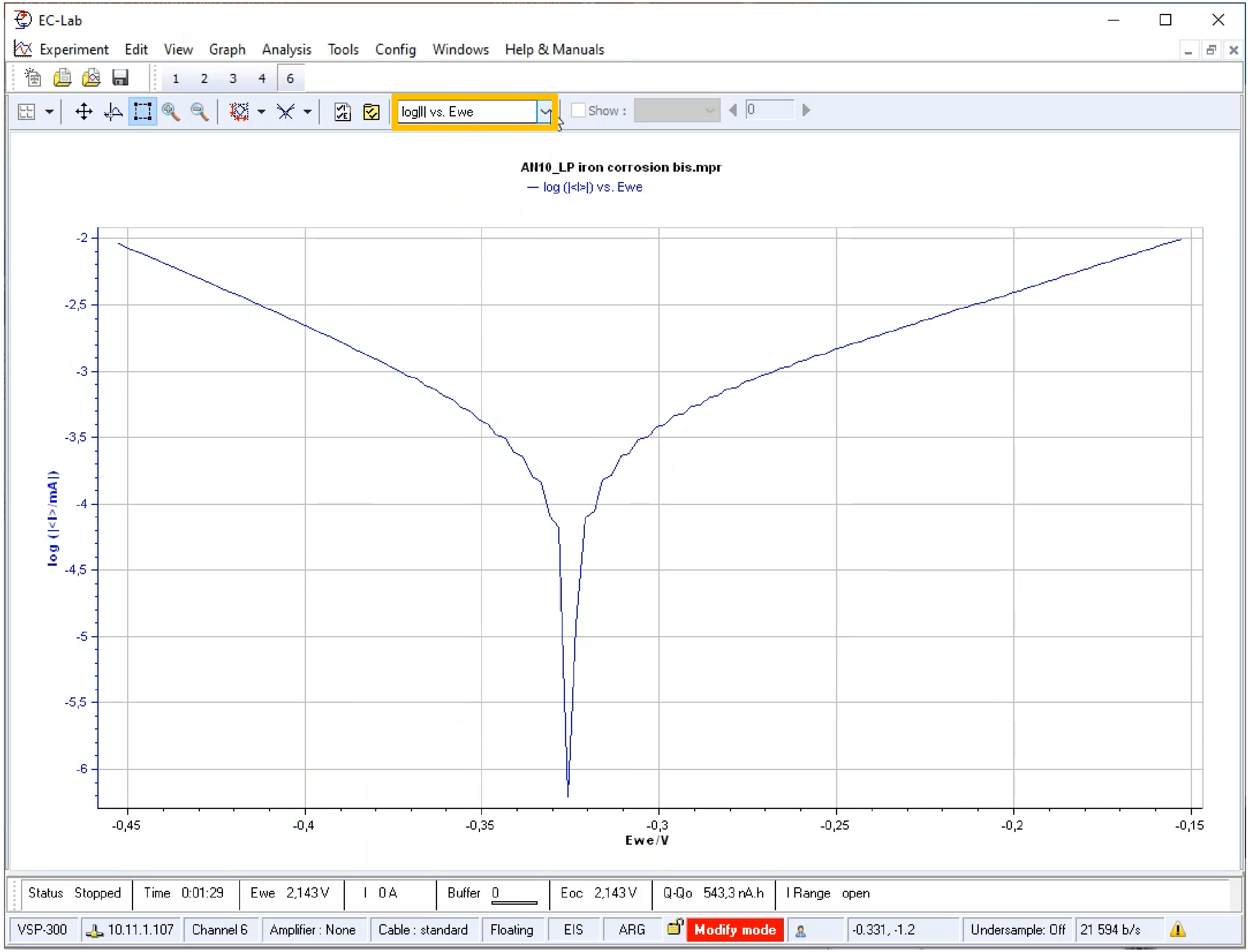
Browse though the graph
(Filter, Scroll, Cursor, Selection, Zoom +, Zoom –, Autoscale)

Modify the graph
(Selector, graphic properties, representations)



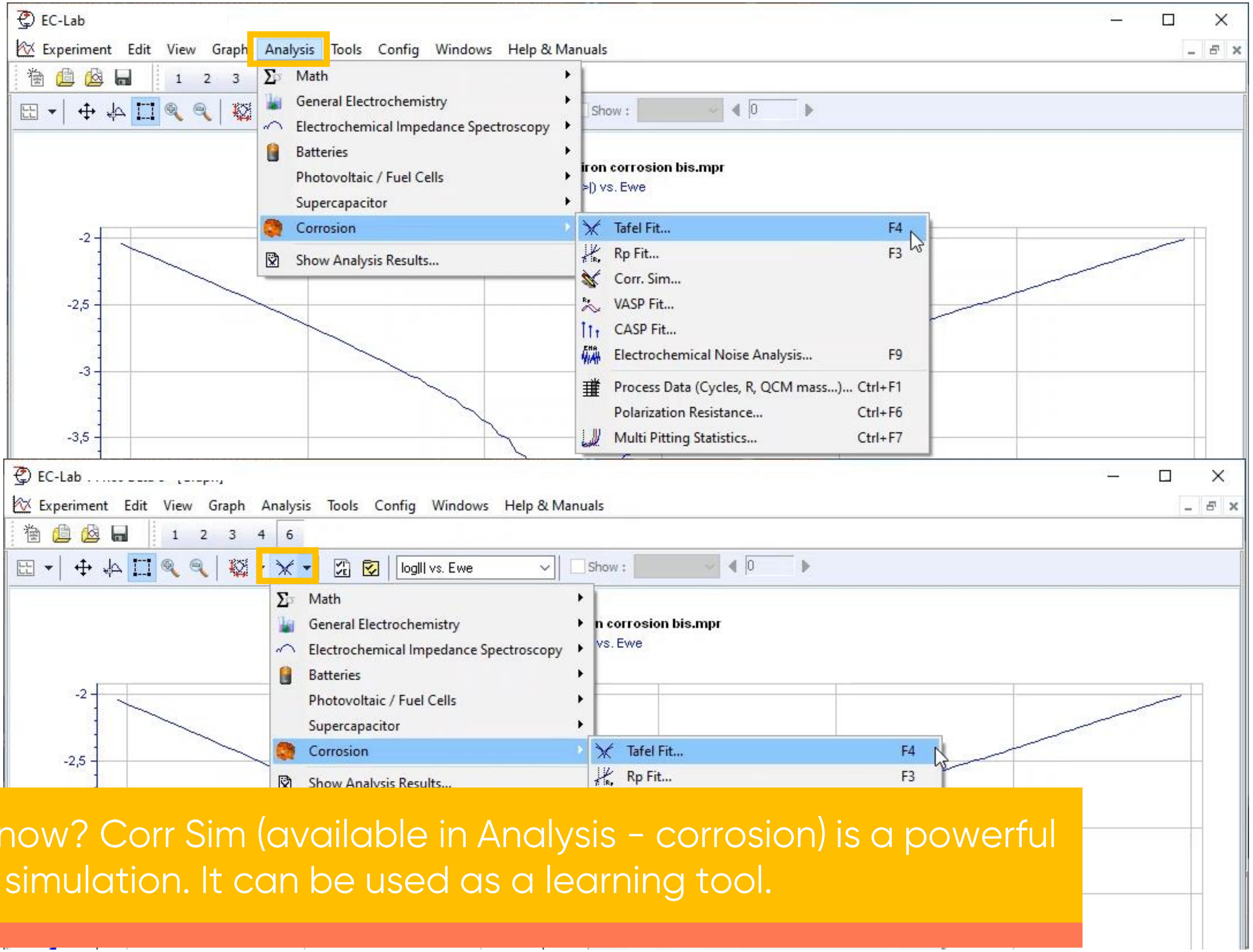
Step 8: Analyse the data with Tafel Fit

- Change representation to log|I| vs. Ewe



Step 8: Analyse the data with Tafel Fit

- Analyse with Tafel Fit

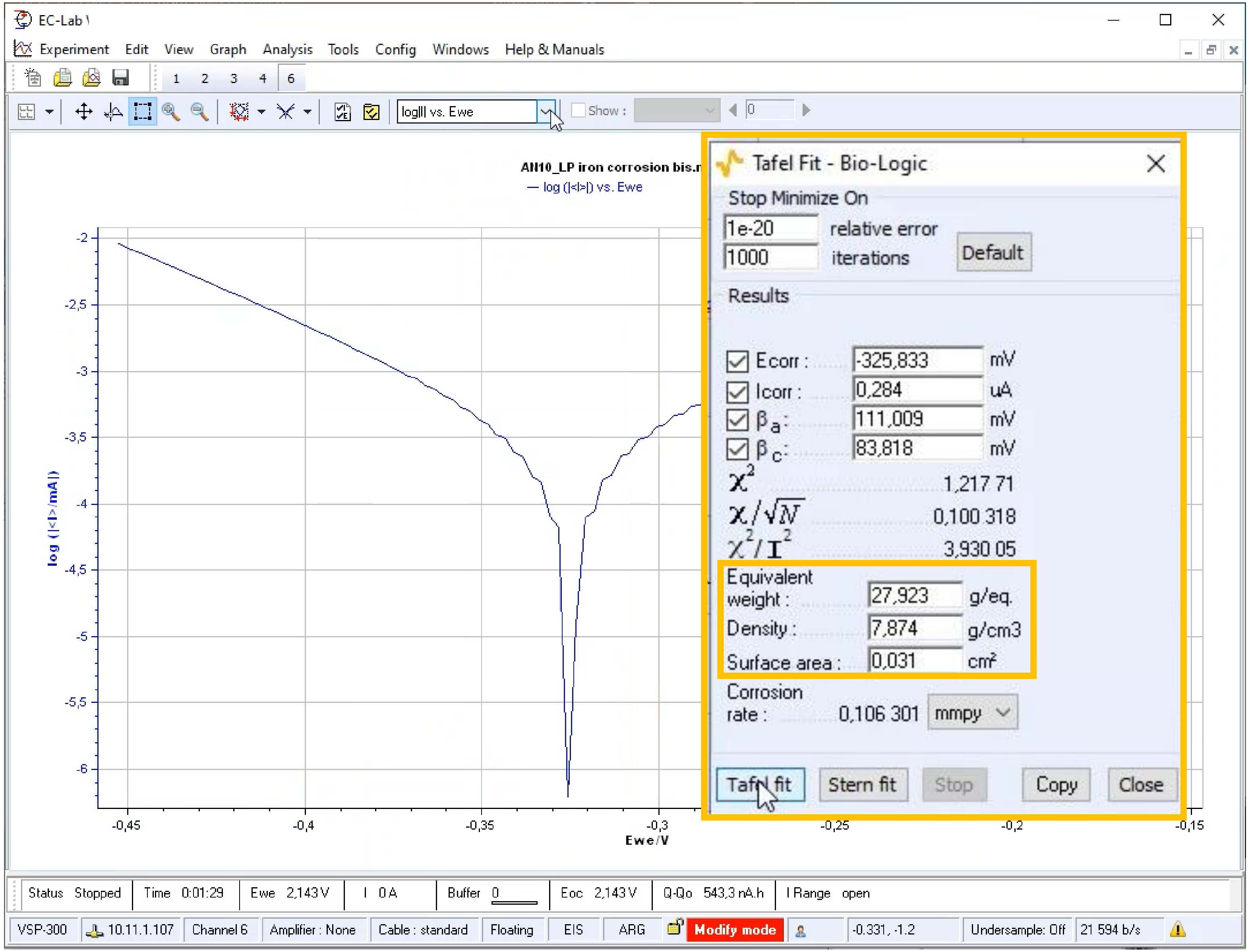


Note: Analysis is available either in the main tool bar or as a shorcut in the graph bar or with F6

Did you know? Corr Sim (available in Analysis – corrosion) is a powerful corrosion simulation. It can be used as a learning tool.

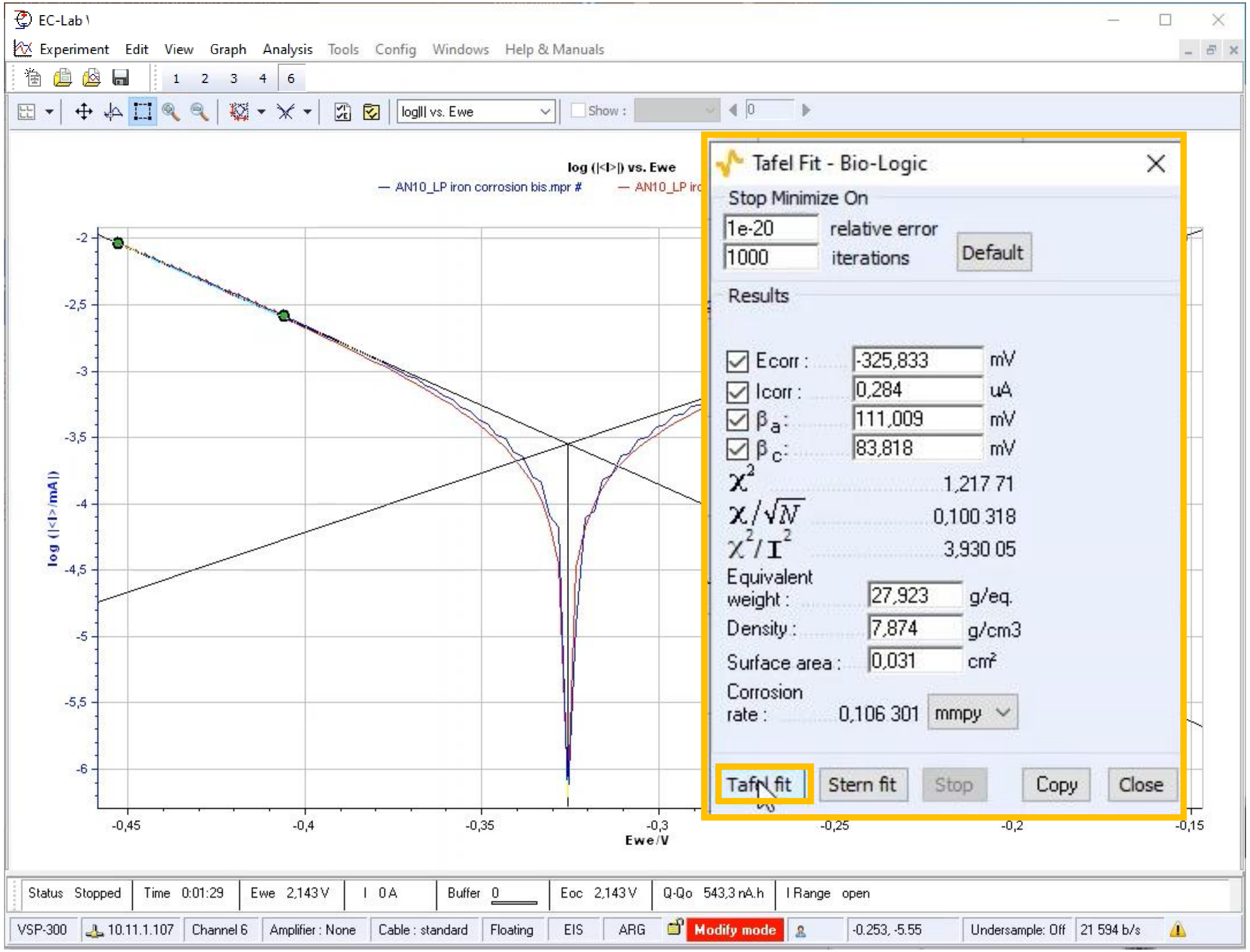
Step 8: Analyse the data with Tafel Fit

- Set sample values (if not provided before in cell characteristics)



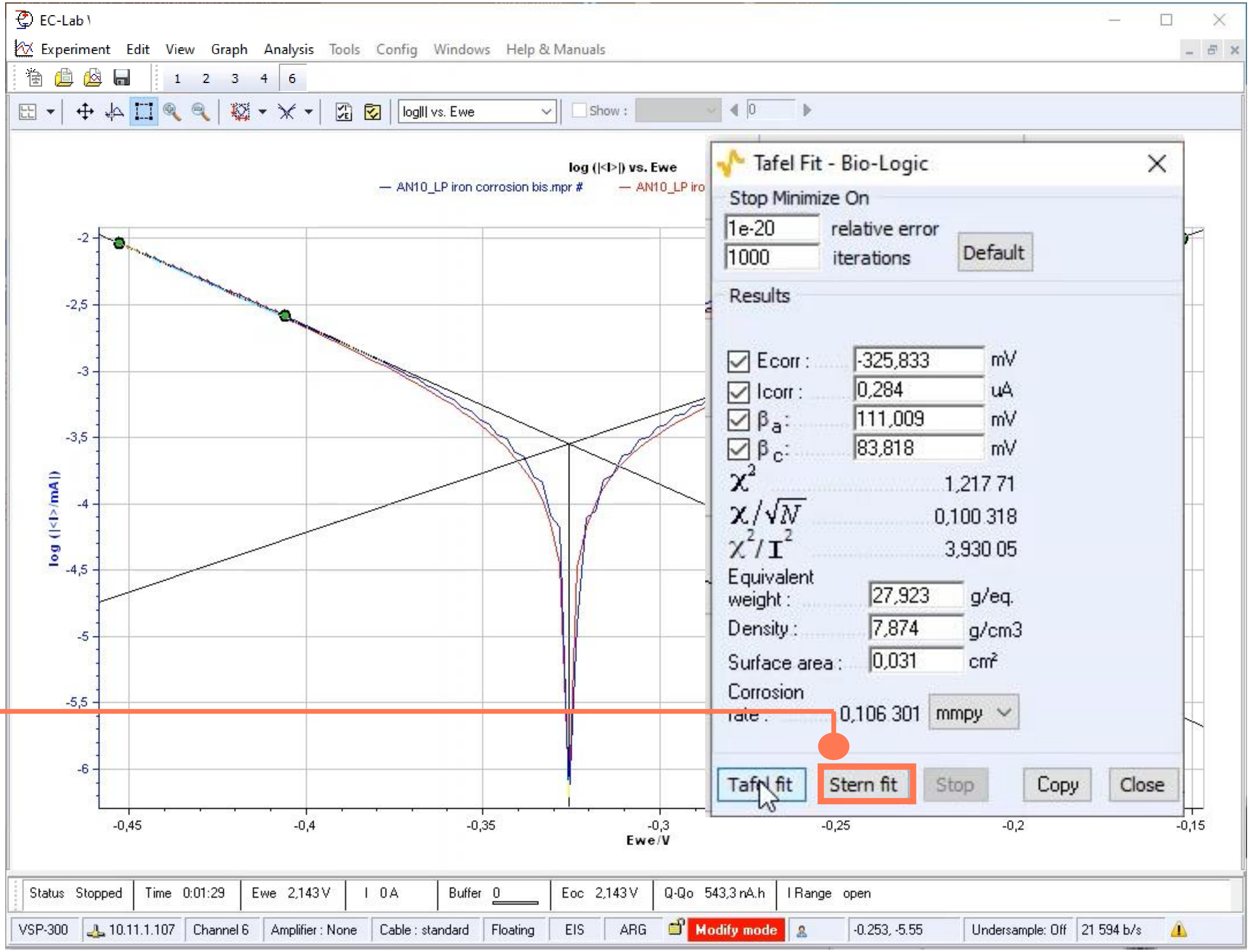
Step 8: Analyse the data with Tafel Fit

- Click on Tafel Fit to calculate



Note: xx_tafel.mpp temporary file is generated. It can be saved as a .mpr file

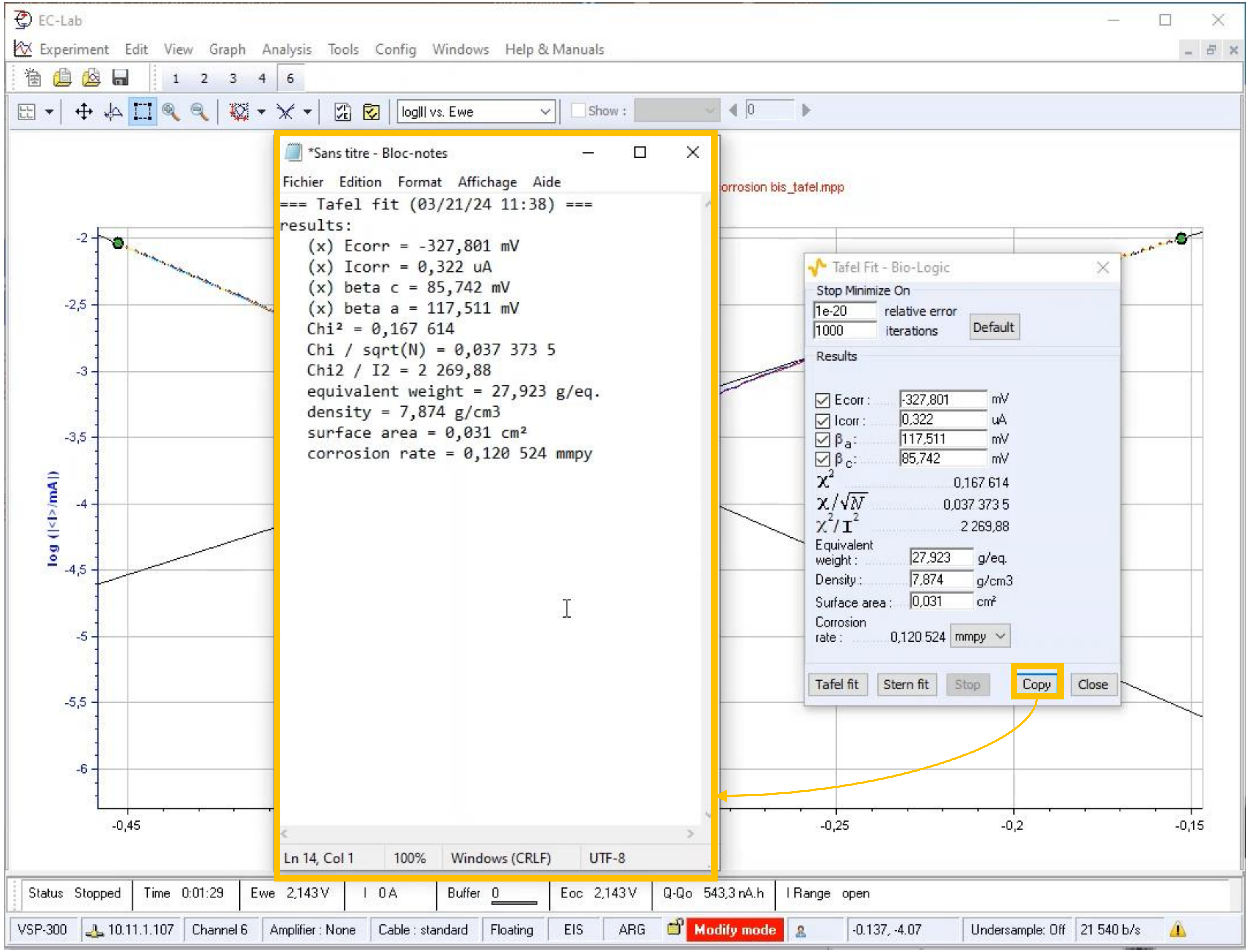
Step 8: Analyse the data with Tafel Fit



A simulated Tafel graph can be displayed if experimental curve is not « tafelian enough »

Step 8: Analyse the data with Tafel Fit

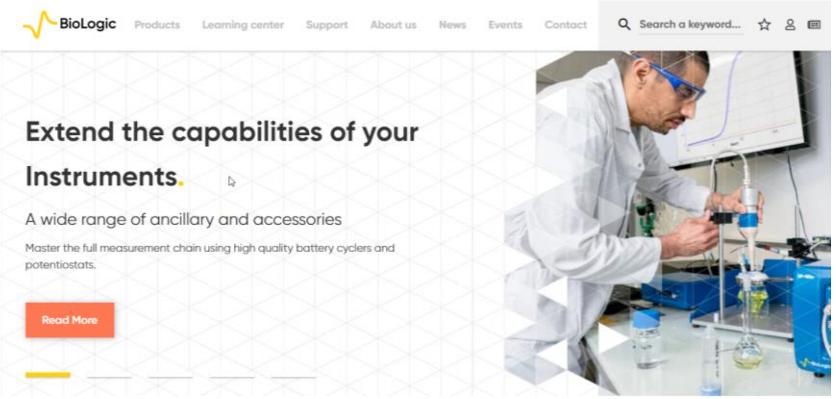
- Save the results with copy/paste

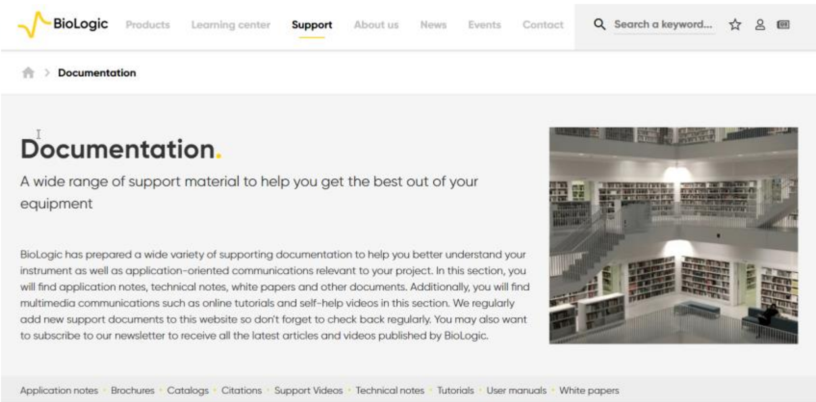


Find out more

For supplementary information

Visit our website!





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- Documentation list
  - Corrosion basics (article)
  - Corrosion current measurement (Application Note #10)
  - 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!

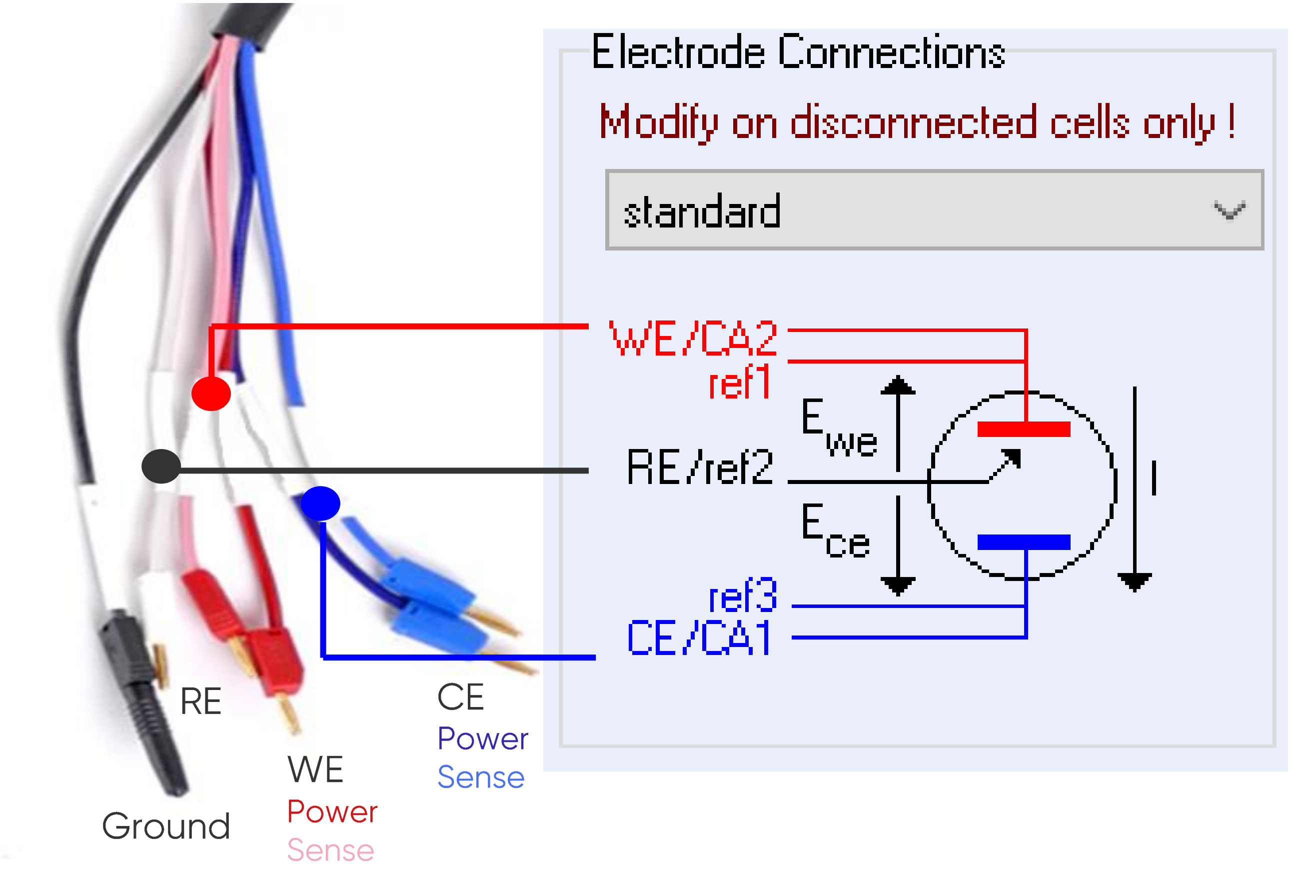
[Contact - BioLogic]

- 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

- How do I connect potentiostat to the cell?
- When should I use floating mode instead of grounded?
- How to optimize the measurement?
- How do I select correct bandwidth?
- Why should I use Rotating Disk Electrode (RDE) during Tafel Plot experiment?

How do I connect potentiostat to the cell?

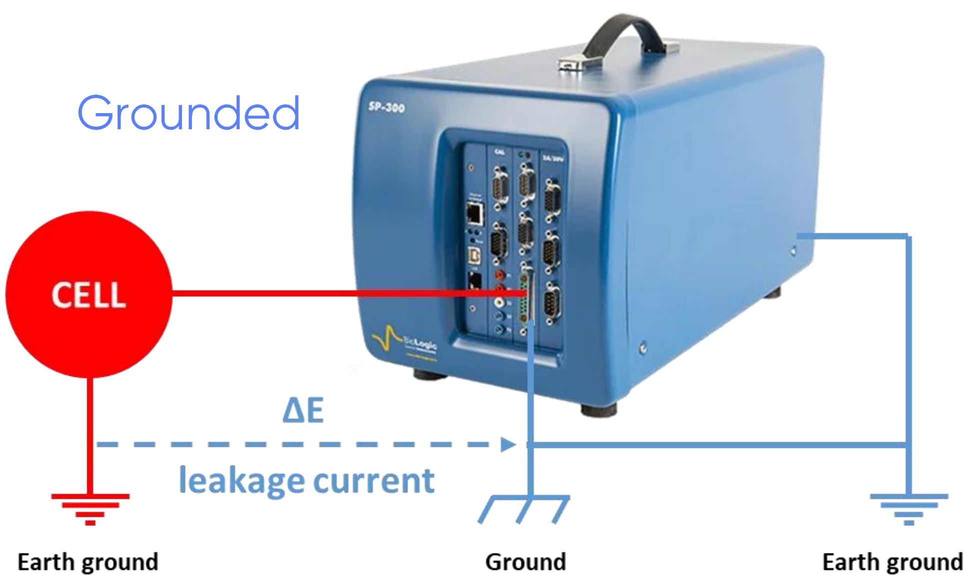


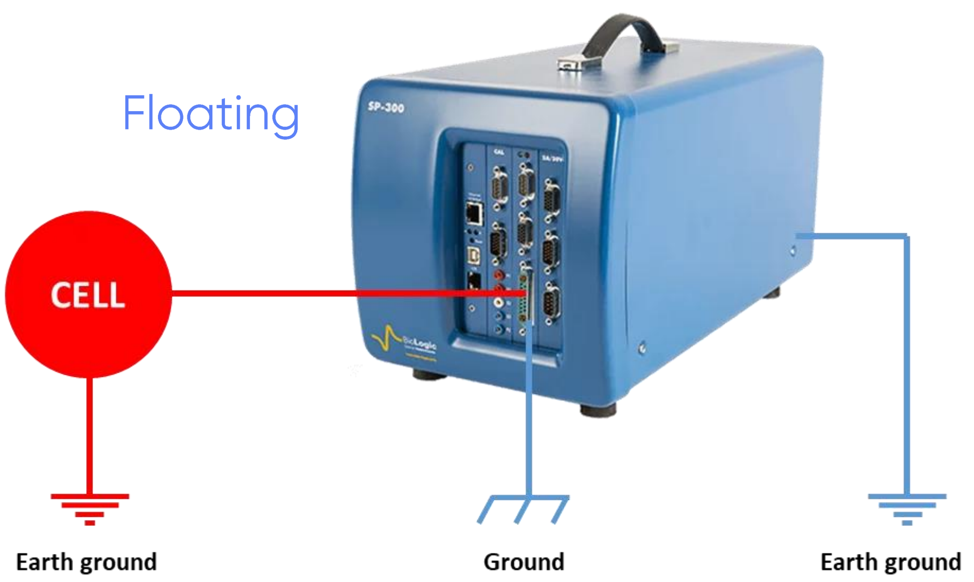
- In standard electrode connections mode:
  - Working Electrode (WE)
    Connect power and sense
  - Reference Electrode (RE)
  - Counter Electrode (CE)
    Connect power and sense

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

When should I use floating mode instead of grounded?

- When the cell is directly connected to the earth, the "floating" connection type is generally used to avoid leakage current





Note: For more details, refer to What is ground? (article)

How to optimize the measurement?

- Accuracy of results is directly related to cell and sample parameters.
- Verify that following conditions are respected:
  - CE surface >> WE surface
  - Constant and stable sample active area
  - Same reference electrode for all measurements

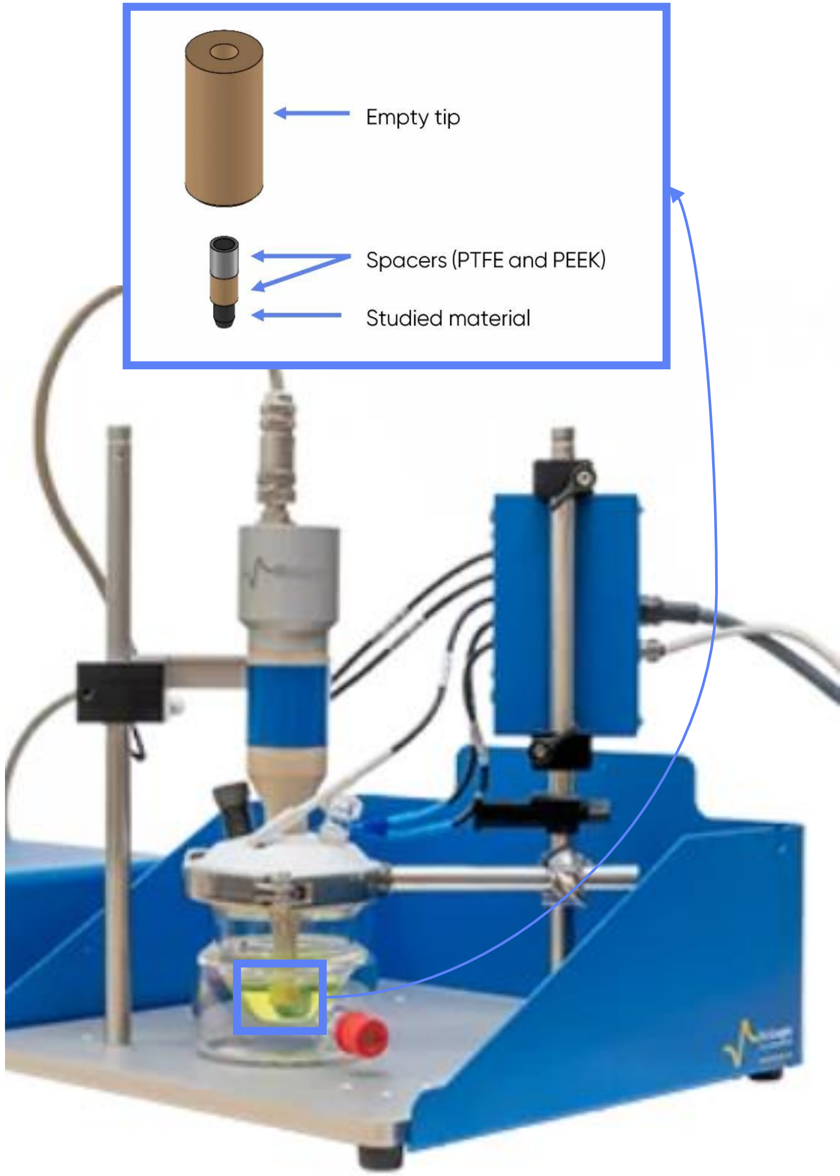
How do I select correct bandwidth?

- To verify quickly if the correct bandwidth is selected (no oscillation and stable measurement), you can follow these steps:
  - Change the Bandwidth factor. Start with a lower value. If decreasing the bandwidth factor does not work, try to increase it. The faster, the better.
  - For potentio-dynamic measurements carried out at high scan rates, fast bandwidths must be set.
  - The hardware ohmic drop compensation slows down the regulation loop, so in some cases, you may need to decrease the bandwidth.
  - For Premium range potentiostats, adjust bandwidths 7, 8, 9 first. Then, if the measurement still shows signs of oscillation try the advanced bandwidths 1 to 6.

Note: To go further, refer to Get more from your potentiostat, Understanding bandwidth & its effect on measurements (articles), Application Note #04; Technical Notes #35

Why should I use Rotating Disk Electrode (RDE) during Tafel Plot experiment?

- Tafel equation is valid if the concentrations at the electrode are approximately equal to the bulk concentrations
- It assumes that the electrode mass transfer rate is not limiting
- RDE ensures the respect of condition to apply Tafel equation (solution convection enables concentration renewal at the electrode)



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Thank you for choosing us!