



BeltApp skin conductance data cleaning manual

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- ✓ SC/EDA basics and key signal parameters
- ✓ Tonic vs. phasic components
- ✓ How to identify artifacts (the "1-3 second rule")
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- ✓ Step-by-step cleaning process
- ✓ The three replacement methods and when to use each
- ✓ Critical save behavior warning

Understanding What You're Cleaning

Skin Conductance (SC) — also known as **Electrodermal Activity (EDA)** — measures changes in sweat gland activity linked to sympathetic arousal.

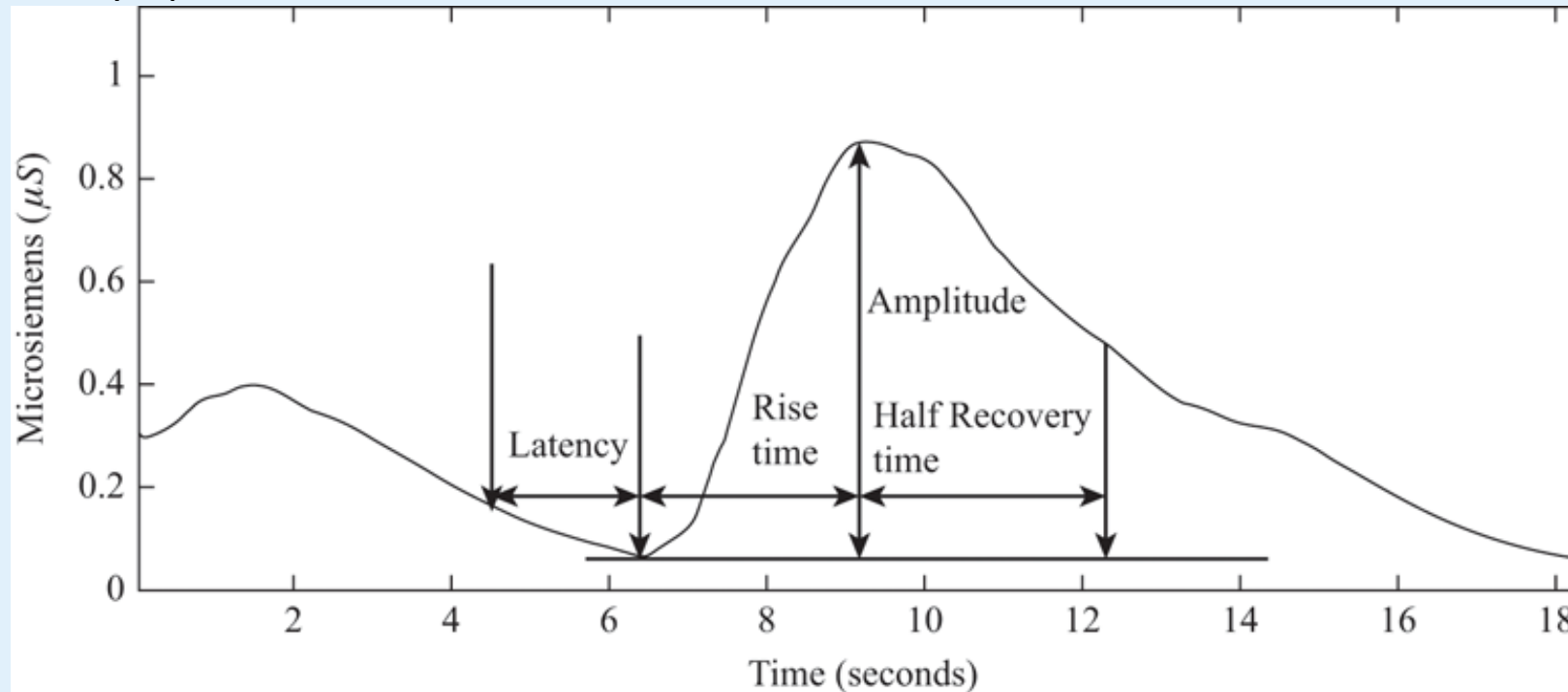


Figure: Example of a typical Skin Conductance Response (SCR). After a stimulus, skin conductance shows a delayed increase (latency), a sharp rise to peak amplitude (rise time), and a gradual decay (half-recovery time). The amplitude reflects the intensity of sympathetic arousal.

Understanding What You're Cleaning

Key Phases Explained

Parameter	Description	Typical Range
Latency	The delay between the stimulus onset and the beginning of the SCR rise . It reflects the time it takes for the sympathetic nervous system to activate sweat glands.	1–4 seconds
Rise Time	The time from the onset of the response to the peak amplitude . It reflects how quickly the arousal develops.	1–3 seconds
Amplitude	The height of the response , measured as the difference in microsiemens (μS) between the baseline and the peak. It indicates the strength of physiological arousal .	$\geq 0.05 \mu\text{S}$ (significant response)
Half-Recovery Time	The time it takes for the signal to drop to half of its peak value after reaching the maximum. It shows how quickly the arousal subsides.	2–10 seconds

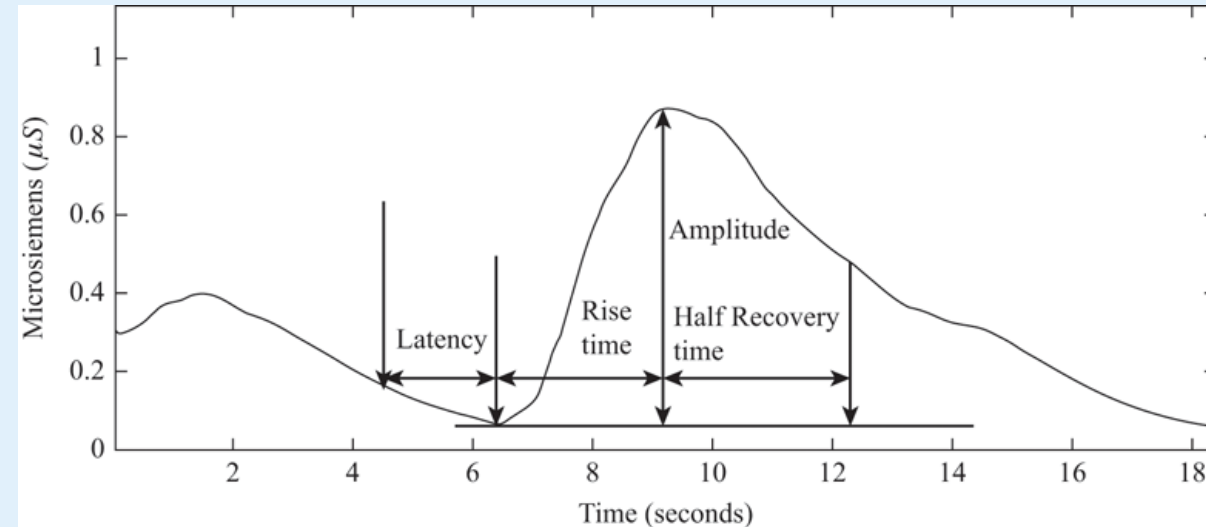


Fig. 1. A Typical GSR Response

Understanding What You're Cleaning

In real life, SCR signals don't happen one at a time.

If someone experiences several emotional or attention-grabbing moments close together, the skin keeps reacting before the previous response has fully faded.

SCR signal shows a moment of arousal — but because our body often reacts several times in a row, the responses overlap, making the raw signal look complex and noisy.

Tonic Component: This is the slow, steady part of the signal — like the “baseline”. It changes gradually over time depending on general factors such as temperature.

Phasic Component: In the raw data, the **quick spikes (actual SCRs)** are not always clear because they **overlap with the slow tonic changes**. When several reactions happen close together, their peaks merge and become difficult to separate visually.

Therefore, **BeltApp** uses a **deconvolution method** to separate the tonic and phasic components mathematically. This allows you to **see the true arousal responses** more clearly — as will be shown in the next steps.

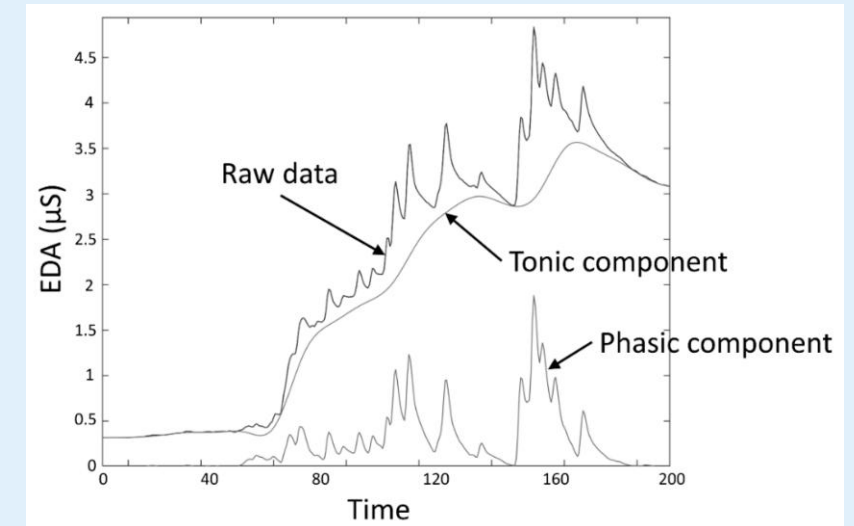


Figure. This is an example raw signal recorded from the skin. It includes **two mixed components**: a **slow tonic trend** and **fast phasic spikes**. In the raw signal, you don't clearly see this separation — both are combined.

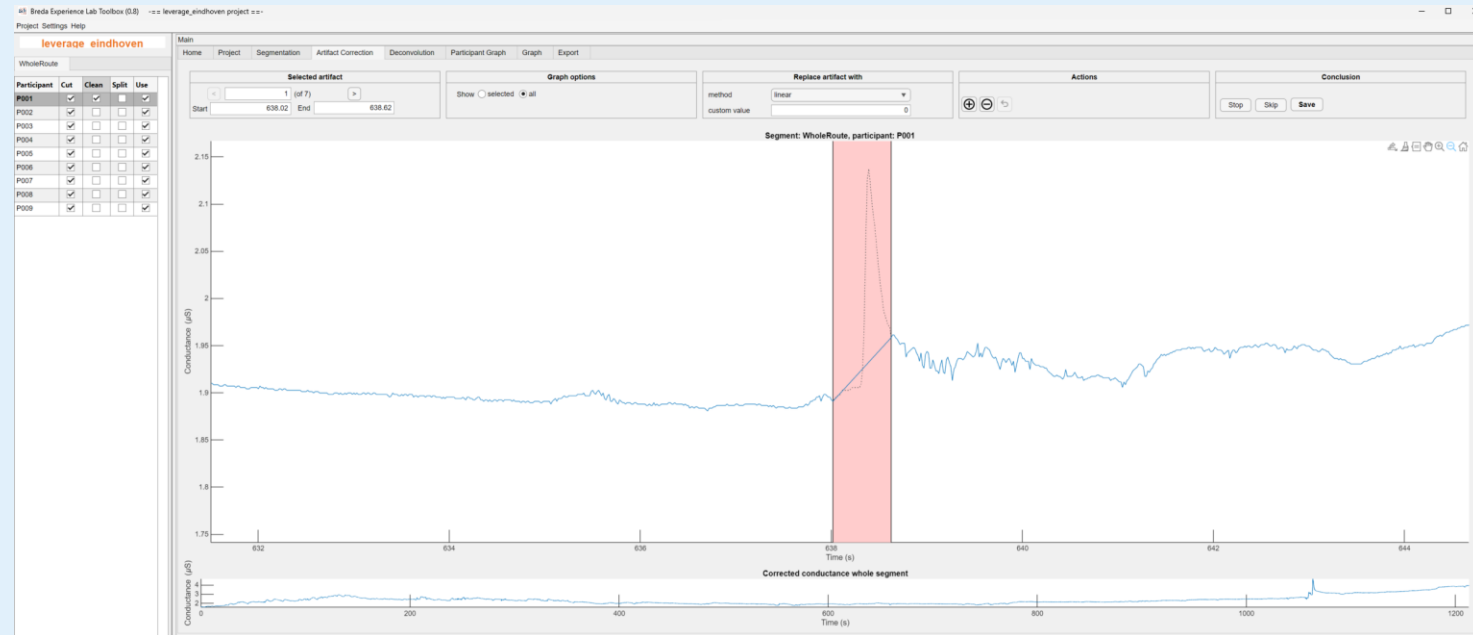
What Is an Artifact in EDA Data?

An **artifact** is a change in the SCR signal that does **not come from the body's physiological response**, but instead from **external disturbances**. Artifacts distort the data and can look like sudden jumps, drops, or noise that does not match normal skin conductance behavior.

Artifacts happen because SCR sensors are **very sensitive to movement, pressure, sweat, and contact quality**.

Common Causes of Artifacts

- Hand or body movement (sudden jumps in the signal)
- Electrode shifting or poor contact
- Sweat accumulation or drying
- Cable pulling or vibration
- Device interference or signal dropouts



In this fig. you can see a **very sharp, steep rise followed by an immediate drop** — this is not a normal physiological SCR.

A **true SCR** develops gradually: it rises over 1–3 seconds and decays slowly.

However, this spike happens almost **instantly**, which indicates **movement or electrode disturbance** rather than real arousal.

How to Spot Artifacts

Look for **unnatural changes** in the signal. Typical artifact patterns include:

Artifact Patterns

Sharp vertical jumps or drops (instant rise/fall)

Flat zero line or sudden drop to 0 μS

Very noisy or jagged segments

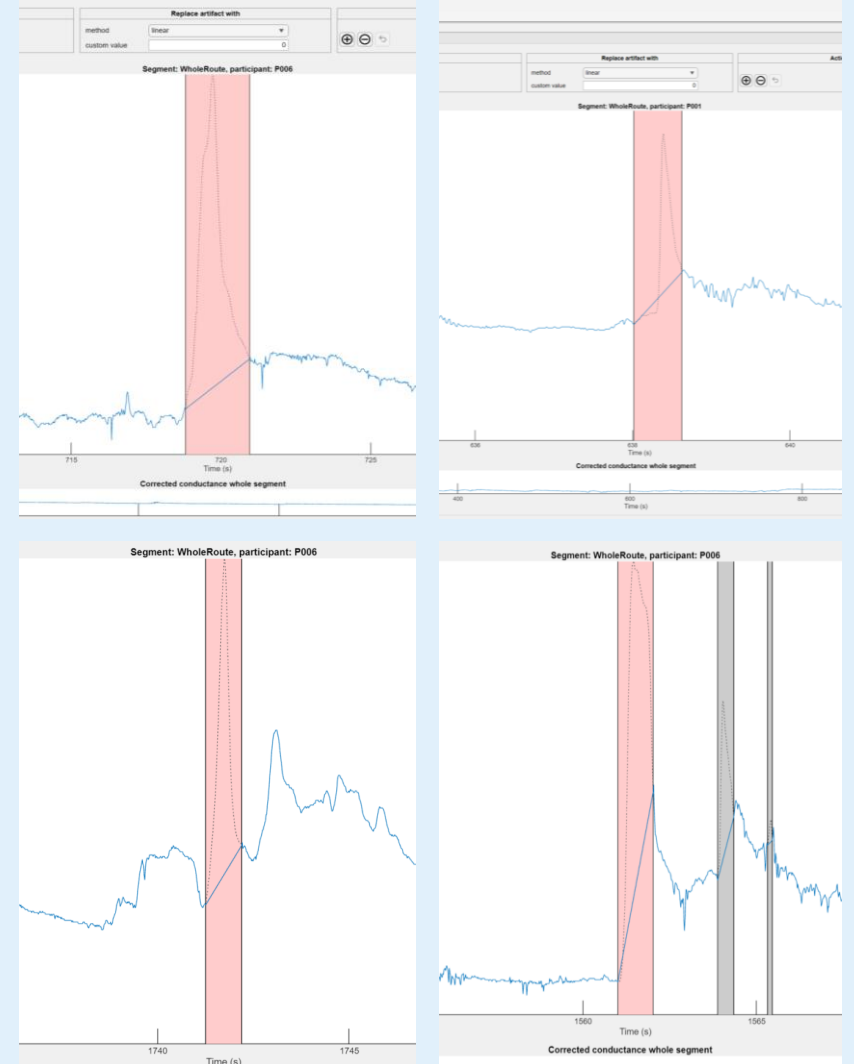
Sudden signal spikes that do not follow SCR shape

Clipped/constant max value

Quick Rule of Thumb

If a change happens faster than the body can react, it is an artifact.

SCRs rise over **1–3 seconds** but an artifact looks **instant**.



Cleaning Skin Conductance Data and Identifying Artifacts in BeltApp



Now you are ready to open the BeltApp

Please note that when you start **BeltApp**, it may take a little while to open.

This delay is completely normal; BeltApp runs on top of MATLAB, which needs to load several background components before the interface appears.

And this delay is also a good opportunity to think about the opportunity cost; all the things that you could do with your life rather than cleaning artifacts..

project name

Segment

Participant Cut Clean Split Use

1. Click here

Project

Processing skin conductance data starts with crea


NEW PROJECT OPEN EXISTING PROJECT

RECENT PROJECTS :

LEVERAGE_EINDHOVEN RECENT2 RECENT3 RECENT4 RECENT5

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Home

The Breda Experience Lab Toolbox (BELT) is an ap

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Log

Starting log ...

MATLAB App

Then you see this pop-up window.

Create a new project

Project name

Project directory

2. Name the project and set the directory

Directories

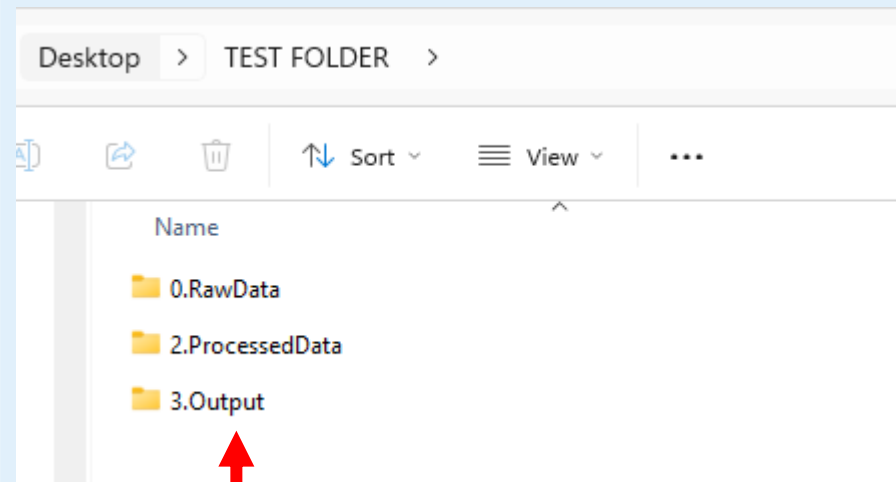
Raw data	<input type="text" value="C:\Users\durgun.s\Desktop\TEST FOLDER\0.RawData"/>	<input type="button" value="Select"/>
Processed data	<input type="text" value="C:\Users\durgun.s\Desktop\TEST FOLDER\2.ProcessedData"/>	<input type="button" value="Select"/>
Output	<input type="text" value="C:\Users\durgun.s\Desktop\TEST FOLDER\3.Output"/>	<input type="button" value="Select"/>

Check directories

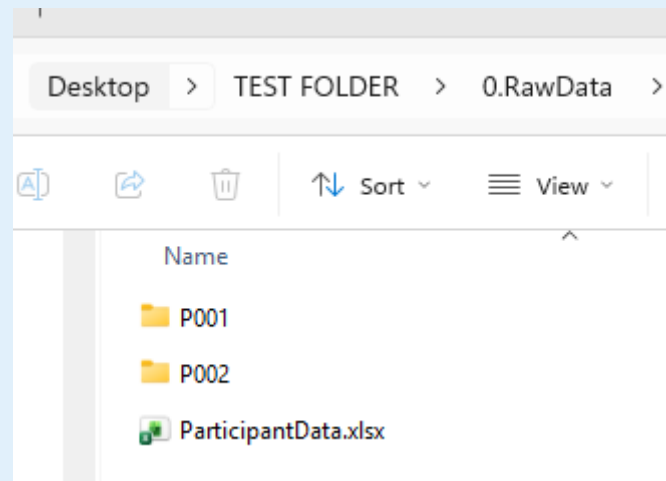
Automatically create directories that do not exist

Ask me what to do for each directory that does not exist

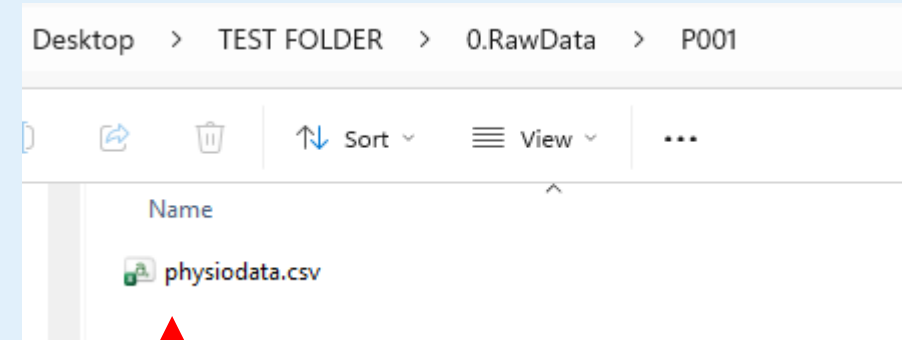
3. Click here



BELTapp creates those folders automatically



1. Move your data into RawData folder.
2. Make sure that you named each participant folder as per on the screenshot



3. Raw data inside the participant's folder must be named as "physiodata"

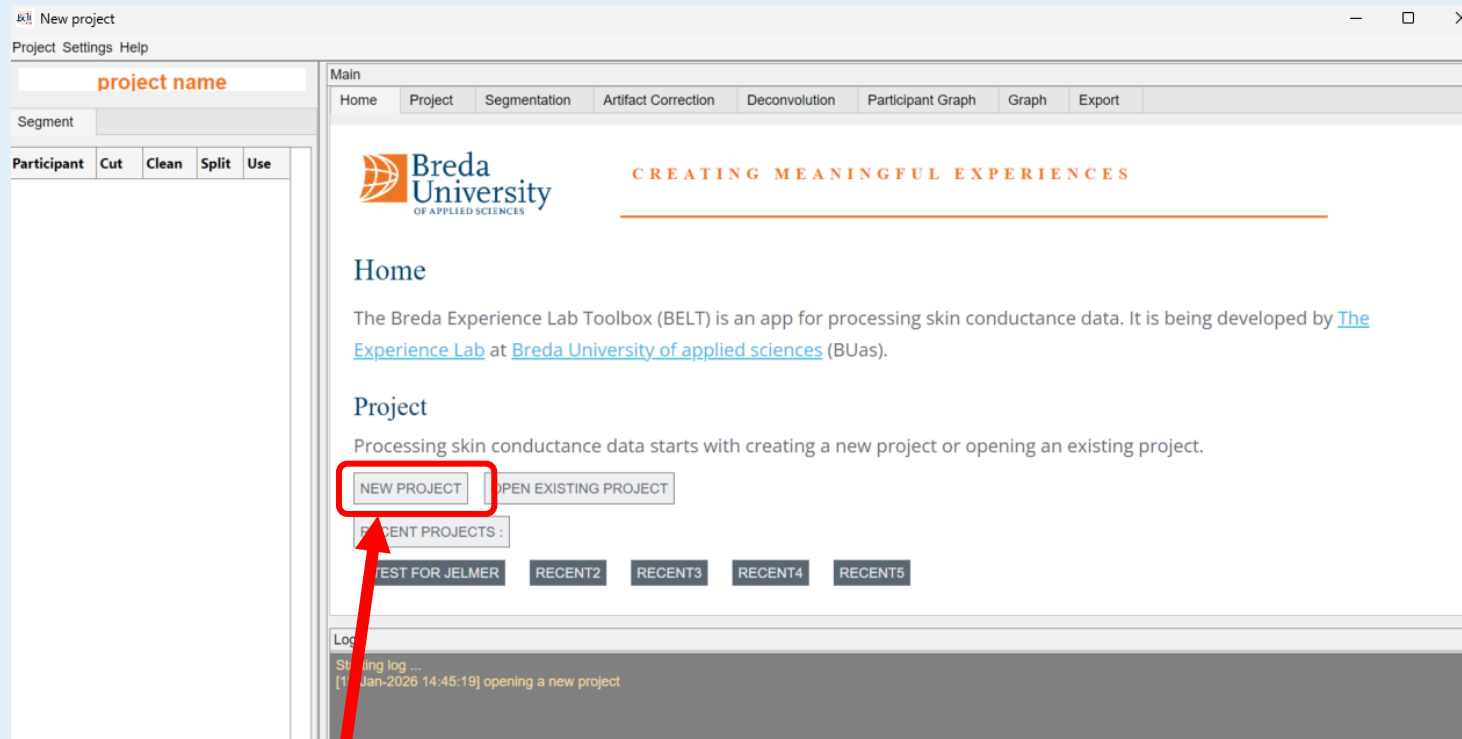
4. Create the "ParticipantData" file based on the right format here>

A	B	C	D	E
Participant	StartTimeWholeRoute	EndTimeWholeRoute	TimeFormat	TimeZone
P001	21-Oct-2025 10:03:25	21-Oct-2025 10:16:27	datetime	Europe/Amsterdam
P002	21-Oct-2025 13:29:09	21-Oct-2025 13:43:33	datetime	Europe/Amsterdam

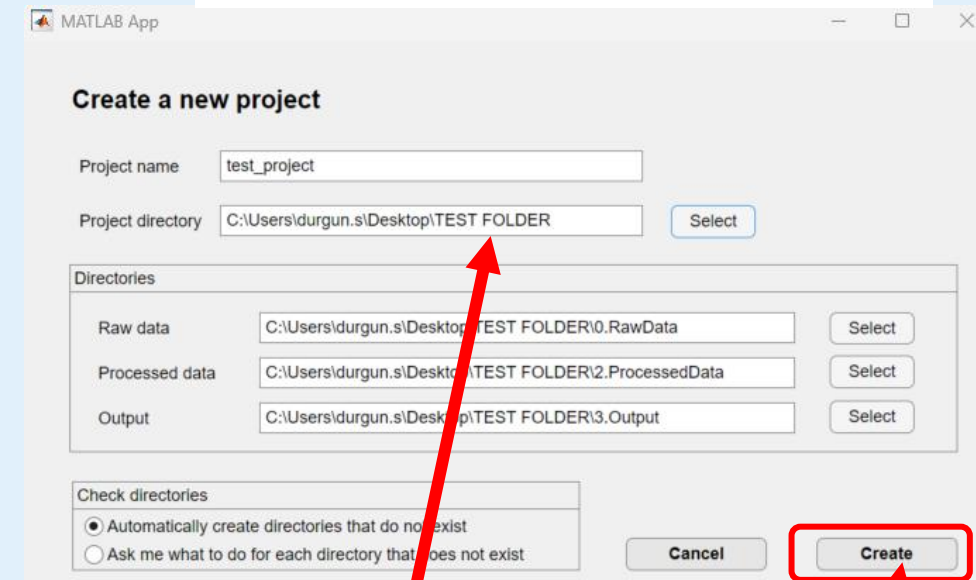
Note: if you do not have exact start&end time you can always write "startfile" and "endfile" here

Once you create the right layout of the folders\file with right formats:

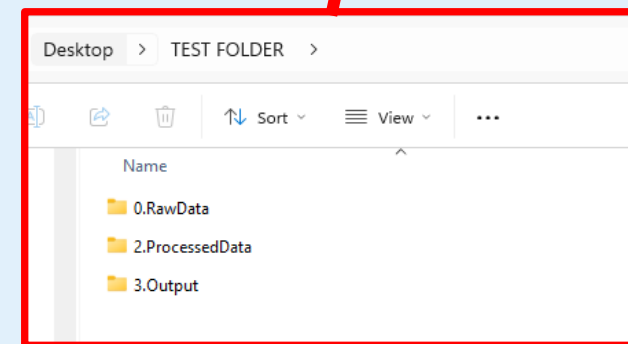
2. Name the project and select the folder location we just generated.



1. Click "new project" again



3. Click create



1. Click here for the segmentation of all data.

Participant	Cut	Clean	Split	Use
P001	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
P002	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Conditions	Test	Condition 2
	0	0
	0	0
	0	0

Segmentation

First, we will cut out the relevant parts of the data using the start and endtimes from the columns 'StartTimeConditionName' and 'EndTimeConditionName'. See the excel file '0.RawData\ParticipantData.xlsx' in the project directory.

Segmentation is complete

You can now proceed with cleaning the data.
Click a box in the Clean column in the table on the left to start the Artifact Correction procedure for that data segment.

Participant	Cut	Clean	Split	Use
P001	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
P002	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Beltapp cuts all the data and segments them based on the onset and offset time you entered into ParticipantData file.

The data are now ready for cleaning!
From this point onward, the data-cleaning steps are demonstrated using a different dataset.

leverage eindhoven

Participant	Cut	Clean	Split	Use
P001	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
P002	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
P003	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
P004	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
P005	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
P006	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
P007	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
P008	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
P009	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>



Make sure all the data are here, and they are selected like this

Main

Home Project Segmentation Artifact Correction Deconvolution Participant Graph Graph Export



CREATING MEANINGFUL EXPERIENCES

leverage_eindhoven

Processing skin conductance data involves several sequential steps: segmenting (cut), artifact correction (clean), deconvolution (split). See the help files for an explanation of each step.

Your project is located in *C:\Users\durgun.s\BUas\602012 - Experience Lab - P14058 - LEVERAGE - P14058 - LEVERAGE\Eindhoven study*.

If ParticipantData.xlsx has changed, click [here](#) to update the data.

Processing status:

Conditions	WholeRoute	Condition 2
Segmentation (Cut)	9	0
Artifact correction (Clean)	0	0
Deconvolution (Split)	0	0

Log

Starting log ...
[4-Nov-2025 14:54:45] existing project 'leverage_eindhoven' opened

Click here and wait for the participants data to show up on the right side like this

leverage eindhoven

WholeRoute

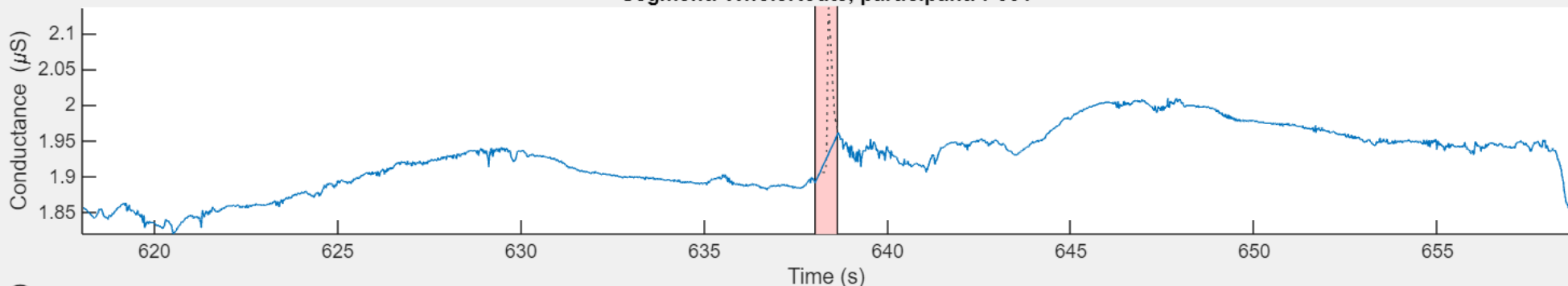
Participant	Cut	Clean	Split	Use
P001	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
P002	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
P003	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
P004	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
P005	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
P006	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
P007	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
P008	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
P009	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Main

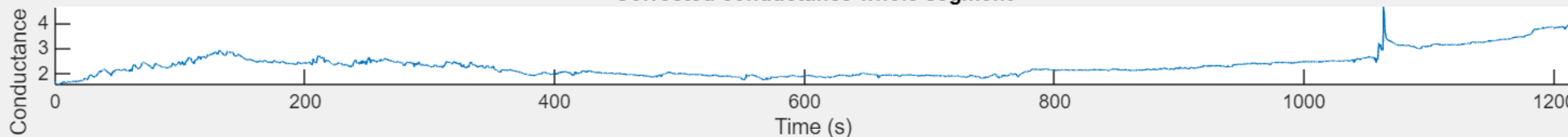
Home Project Segmentation Artifact Correction Deconvolution Participant Graph Graph Export

Selected artifact	Graph options	Replace artifact with	Actions	Conclusion
< 1 (of 7) > Start 638.02 End 638.62	Show <input type="radio"/> selected <input checked="" type="radio"/> all	method linear ▾ custom value 0	<input type="button" value="⊕"/> <input type="button" value="⊖"/> <input type="button" value="↶"/>	<input type="button" value="Stop"/> <input type="button" value="Skip"/> <input type="button" value="Save"/>

Segment: WholeRoute, participant: P001



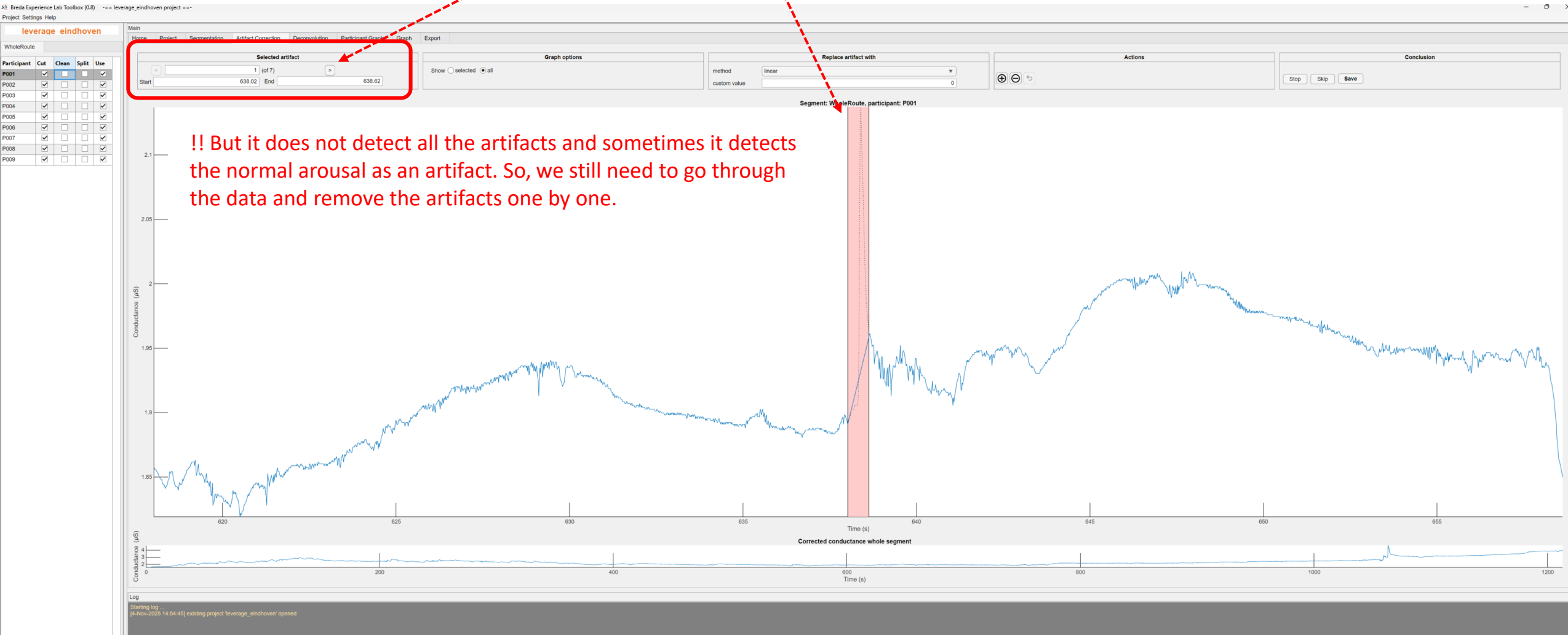
Corrected conductance whole segment



Log

Starting log ...
 [4-Nov-2025 14:54:45] existing project 'leverage_eindhoven' opened

- When you select full screen, it looks like this
- The BeltApp automatically marks suspicious segments with red boxes.
- In this case, it's detected 7 potential artifacts
- You can check them by clicking right/left arrows.



Visual Inspection - Manual Review

Now comes the critical part: **YOU must review each flagged segment AND look for missed artifacts.**

Example 1: Correctly Detected Artifact

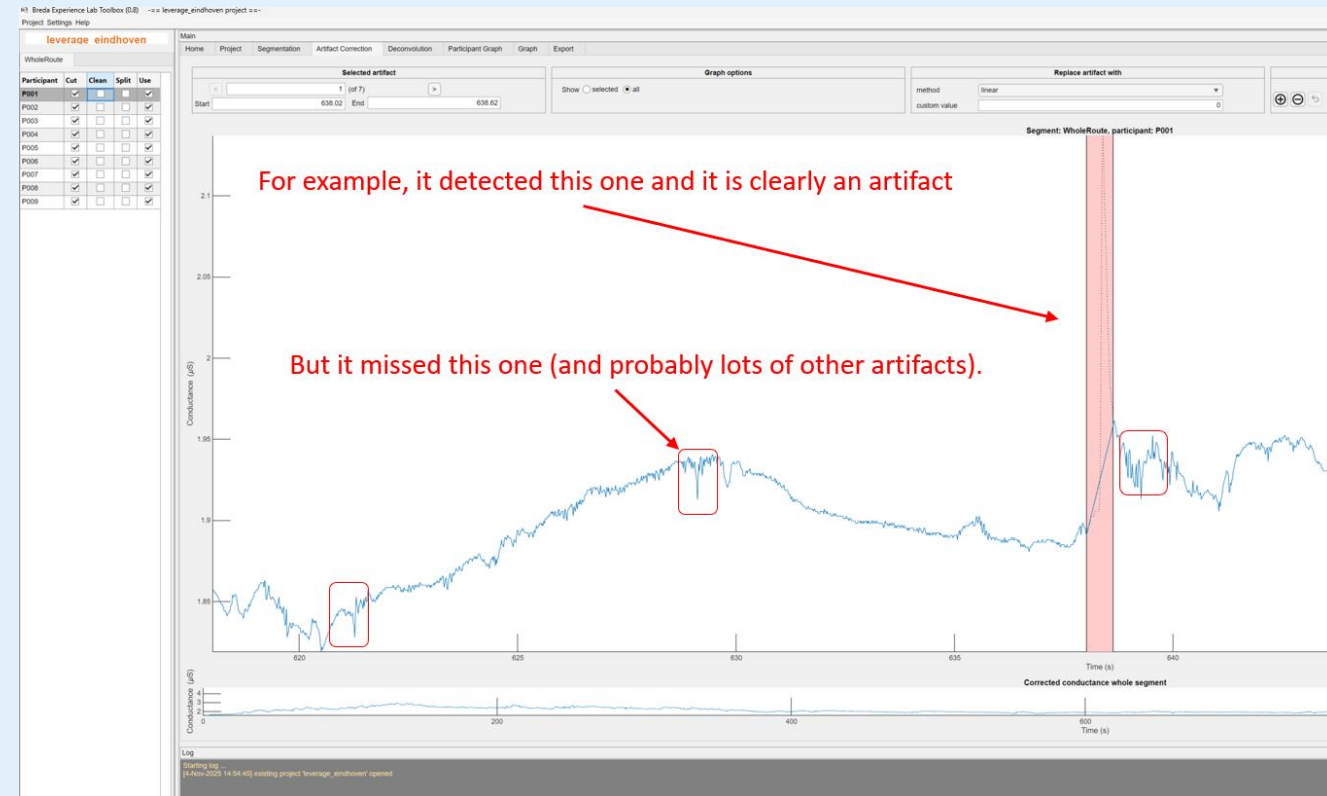
The large red box on the right shows a **sharp, sudden drop** followed by erratic fluctuations:

- **Shape:** Unnatural spike and steep decline, not a smooth physiological curve
- **Action:** ✓ Keep this flagged - definitely an artifact

Example 2: MISSED Artifact (little 3 red boxes)

BeltApp failed to detect these clear artifacts:

- **What you see:** A small, irregular bump with sharp edges
- **Why it's an artifact:**
 - Too sharp/angular (real SCRs are smooth and rounded)
 - Irregular shape - doesn't follow typical rise/recovery pattern
 - No smooth exponential decay
 - Appears as "noise on noise" rather than a clear response
- **Action:** X You must MANUALLY mark this as an artifact




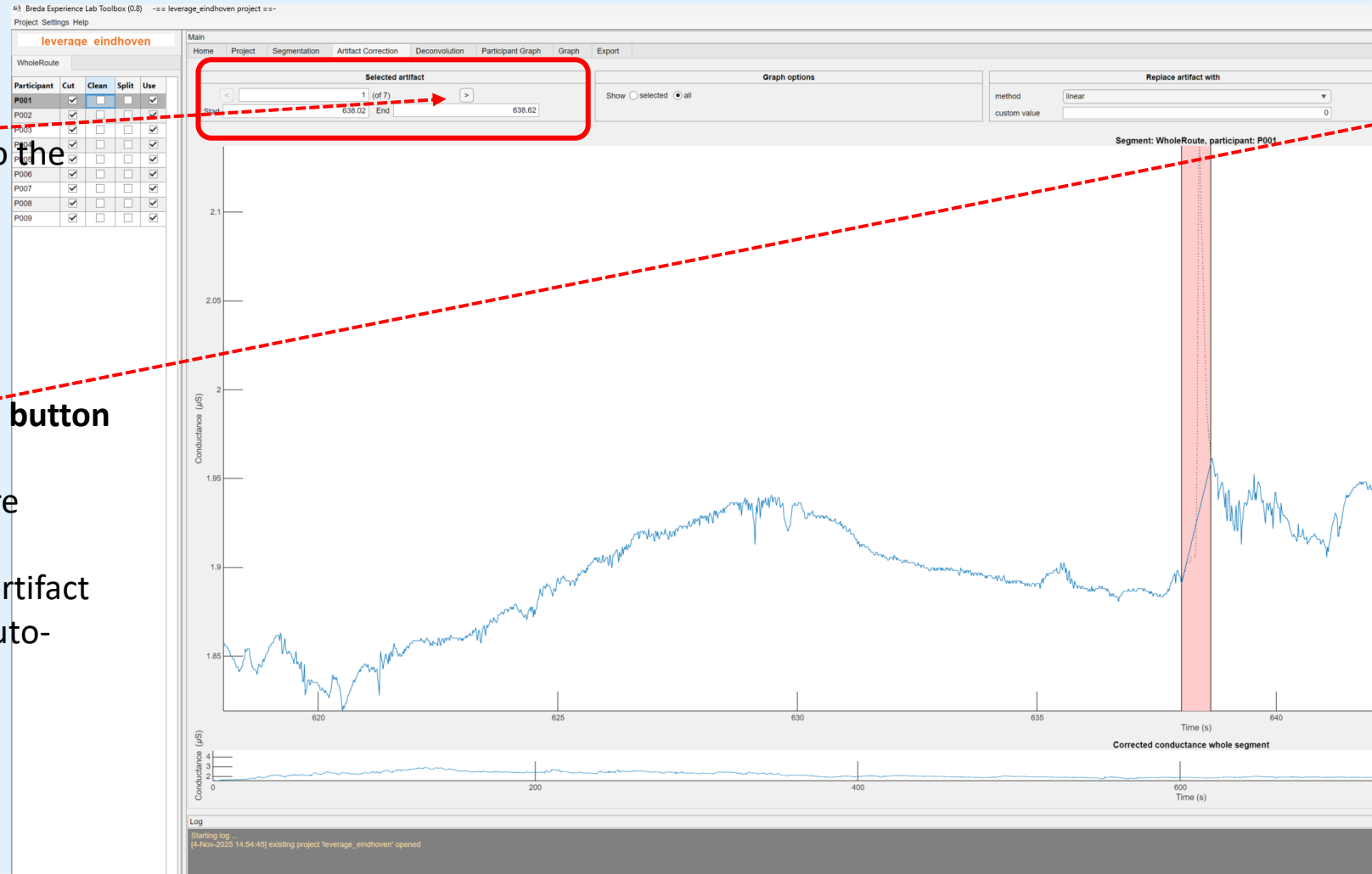
Review Auto-Detected Artifacts

If it IS an artifact (TRUE positive):

- Simply click the **right arrow (→)** button to move to the next detected artifact
- The red box stays marked for later removal
- Move on to review the next flagged segment

If it is NOT an artifact (FALSE positive):

- In the **Action Panel** (right side), click the **minus (-) button**
- This removes the red box from this segment
- The algorithm incorrectly flagged valid data - you're correcting it
- Click the **right arrow (→)** to continue to the next artifact
-  **Repeat this process** until you've reviewed all auto-detected artifacts.



Manual Artifact Detection

⚠ Critical: The automated detection **WILL miss artifacts** (as shown in your example). You must now manually scan the entire dataset.

Reset Your View to the Beginning

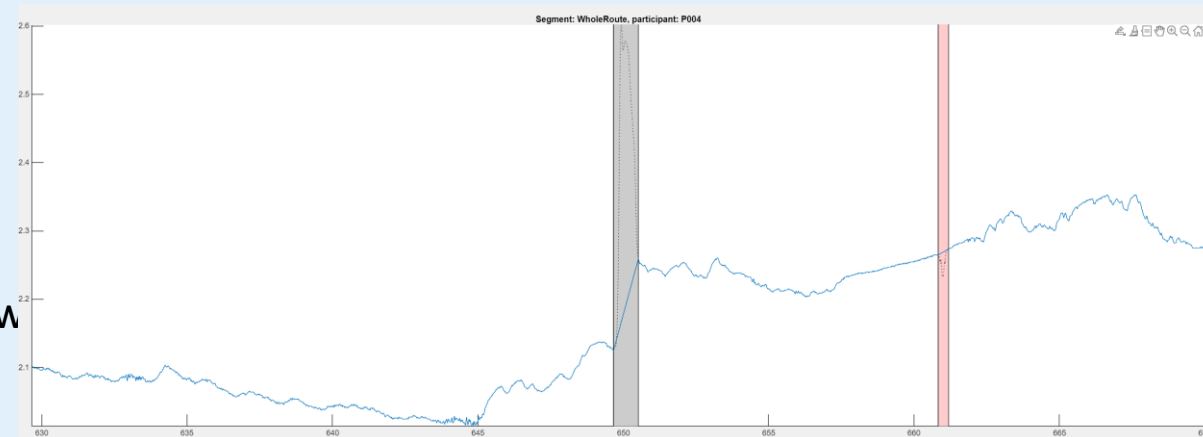
1. Navigate to data start:

1. Use the **navigation tools** (top right of the data visualization panel)
2. Available tools: Brush, Zoom in/out, Hand, Home
3. Click **Home** or drag the timeline back to **0 seconds**



2. Set optimal zoom level for artifact detection:

1. **Horizontal (X-axis/Time):** Zoom to show **~5 second intervals** of data on screen
2. **Why 5 seconds?** This resolution allows you to see:
 1. SCR rise times (1-3 sec)
 2. Recovery phases (2-10 sec)
 3. Small artifacts that appear as brief disturbances
3. **Vertical (Y-axis):** Adjust so you can see full signal range w



Example of 5sec intervals

Manual Artifact Detection

When you identify an artifact that BeltApp missed:



1. Click the Brush icon

2. Select the artifact boundaries:

1. Click at the **START** of the artifact (where signal becomes abnormal)
2. Drag to the **END** of the artifact (where signal returns to normal pattern)
3. OR: Click start point, then click end point (depends on BeltApp version)
4. The selected region should now be highlighted

⚠ Selection Tips:

- **Include the entire disturbance** - from where it deviates to where it normalizes
- **Don't over-select** - only mark the truly problematic portion
- **Check both sides** - ensure you're connecting clean data points

🔑 **CRITICAL DECISION:** How you fill in the artifact gap determines data quality.

Once selected, choose your replacement method in the "**Replace artifact with**" panel:

LINEAR: Stable and similar baselines on both sides

SPLINE: Where data shows clear upward/downward trends

NaN: When you cannot reliably predict what the signal should be

⚠ **Use sparingly!** NaN removes data entirely. Only use when interpolation would be misleading.

Manual Artifact Detection

Apply and Continue

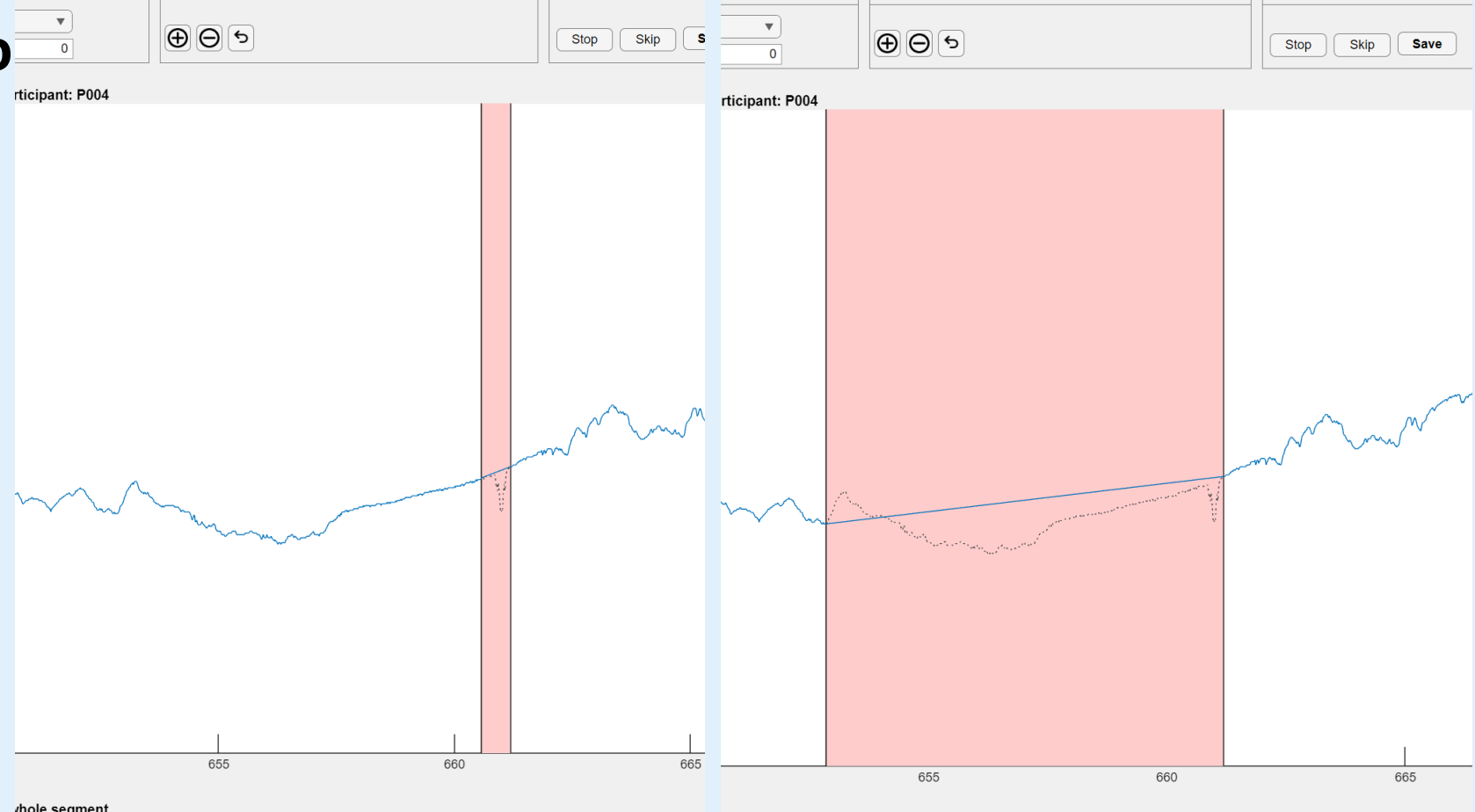
1. After selecting your method (Linear/Spline/NaN), click **Apply** or **OK**

2. The artifact is now corrected - red box disappears, replaced by your interpolation

3. **Visually verify** the correction looks natural

4. **Continue scanning** - pan to the next 5-second window

5. **Repeat Steps 5-7** until you reach the end of the recording



As you can see once you select the artifact you can drag the red box and adjust the size of the correction.

Manual Artifact Detection


Once you've completed cleaning for one participant:

1. Click "Save"
2. BeltApp will automatically:
 - a) Save all your artifact corrections
 - b) Close the current participant's data
 - c) Load the NEXT participant automatically
3. You'll see the next participant's data appear on screen
4. Repeat the steps for this new participant

Final Save




After completing the last participant:

1. Click "Save" one final time
2. This ensures the last participant's corrections are stored

 **CRITICAL: Save Only When Fully Complete**
BeltApp does NOT auto-save or save partial work.

If you close the program or switch participants before clicking "Save," **all your cleaning work will be lost.**

Correct workflow:

1.  Finish cleaning the **entire participant** (all phases complete)
2.  Click "**Save**"
3.  Only then move to next participant or close BeltApp

→ One participant = One complete cleaning session = One save

That's all!



For any inquires please contact:
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