2BarG

PROGRAM MANUAL

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Contents

Introduction

When a split Hopkinson pressure bar experiment is made, two signals are produced – Incident and Transmitted. The *incident* wave is the first stress wave to reach the string gauge (a strain sensor located on the cylindrical bar, marked in a yellow rectangle in figure); the *transmitted* wave is the wave that propagates through the specimen into the second bar. We define the *reflected* wave as is the returning wave after reaching the bar's free boundary.
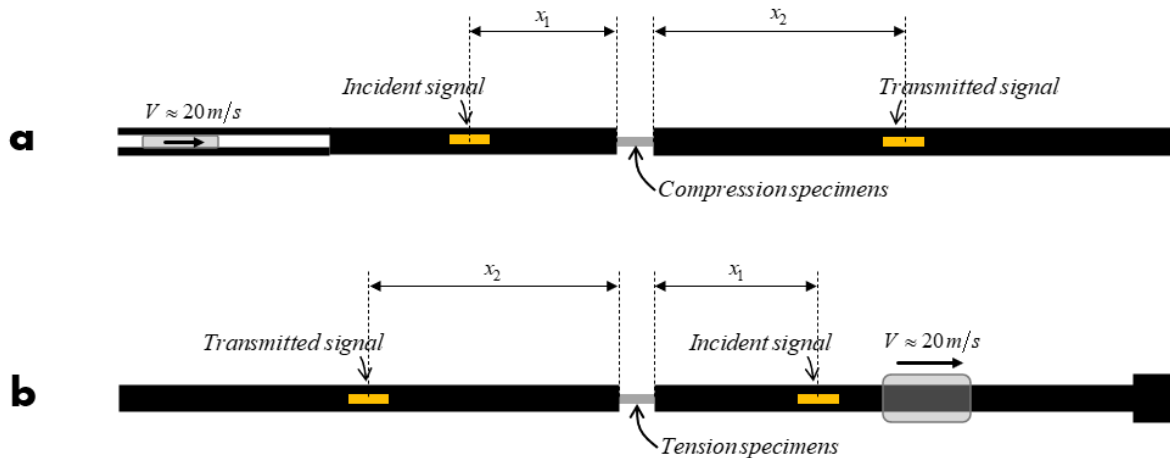
where **a** is the case for compression experiments, and **b** is the case for tension experiments.

Preparing the files

File preparation is crucial for the program to work properly. The program only loads **numbered WFT / FLT / Excel (xlsx) / CSV / ASCII (txt)** file types. Start by creating / using an **empty** folder to store your experiment files in, and from now on this will be your **path folder**.

In the split Hopkinson pressure bar experiment, there should be two output signal files: Incident & Transmitted. The 2BarG program will always read the *incident* signal as **first** and *transmitted* as **second** (*incident, transmitted, incident, transmitted…*), resulting an even number of total signal files. Always start your numbering with a zero digit (01, 02…, 024, etc.), and use consecutive numbering. Note that it is only necessary to have the numbering in your file name – besides numbering you can name your file as you like (for example: 'my_signal01', 'shpb_023').

If for any reason you have an uneven number of files from your experiment, loading all of them in your path folder will result in an unused file.

In the example shown, E01.WFT is an *incident* signal, E02.WFT is a *transmitted*, E03.WFT is an *incident* signal again and so on.
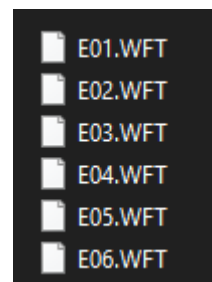
Once your path folder is ready, you can go ahead and run 2BarG.

Starting up 2BarG

Once downloaded the latest version of 2BarG from https://rittel.group/downloads/ , you can find the executable (.EXE) file for 2BarG inside:

_uuid.pyd	19/01/2022 8:25	Python Extension ...	22 KB
_win32sysloader.pyd	19/01/2022 8:25	Python Extension ...	12 KB
2BarG.exe	23/02/2022 12:20	Application	27,567 KB
2BarG.ico	23/02/2022 11:40	Icon	265 KB
2BarG.png	23/02/2022 11:40	PNG File	19 KB
bancrofts_data.txt	28/06/2021 5:44	Text Document	2 KB

If you are having a hard time finding the file, sort the files in the folder from largest to smallest, 2BarG should be the 3rd largest file:

Name	Date modified	Type	Size
libopenblas.EL2C6PLE4ZYW3ECEVIV3OX...	19/01/2022 8:25	Application exten...	34,980 KB
libopenblas.XWYDX2IKJW2NMTWSFYNG...	19/01/2022 8:25	Application exten...	33,679 KB
2BarG.exe	23/02/2022 12:20	Application	27,567 KB

Run the application and start initializing your experimental data (as explained in the next page).

Initializing Experimental Data

2BarG will open in the 'Parameters' tab, where you can find various options:
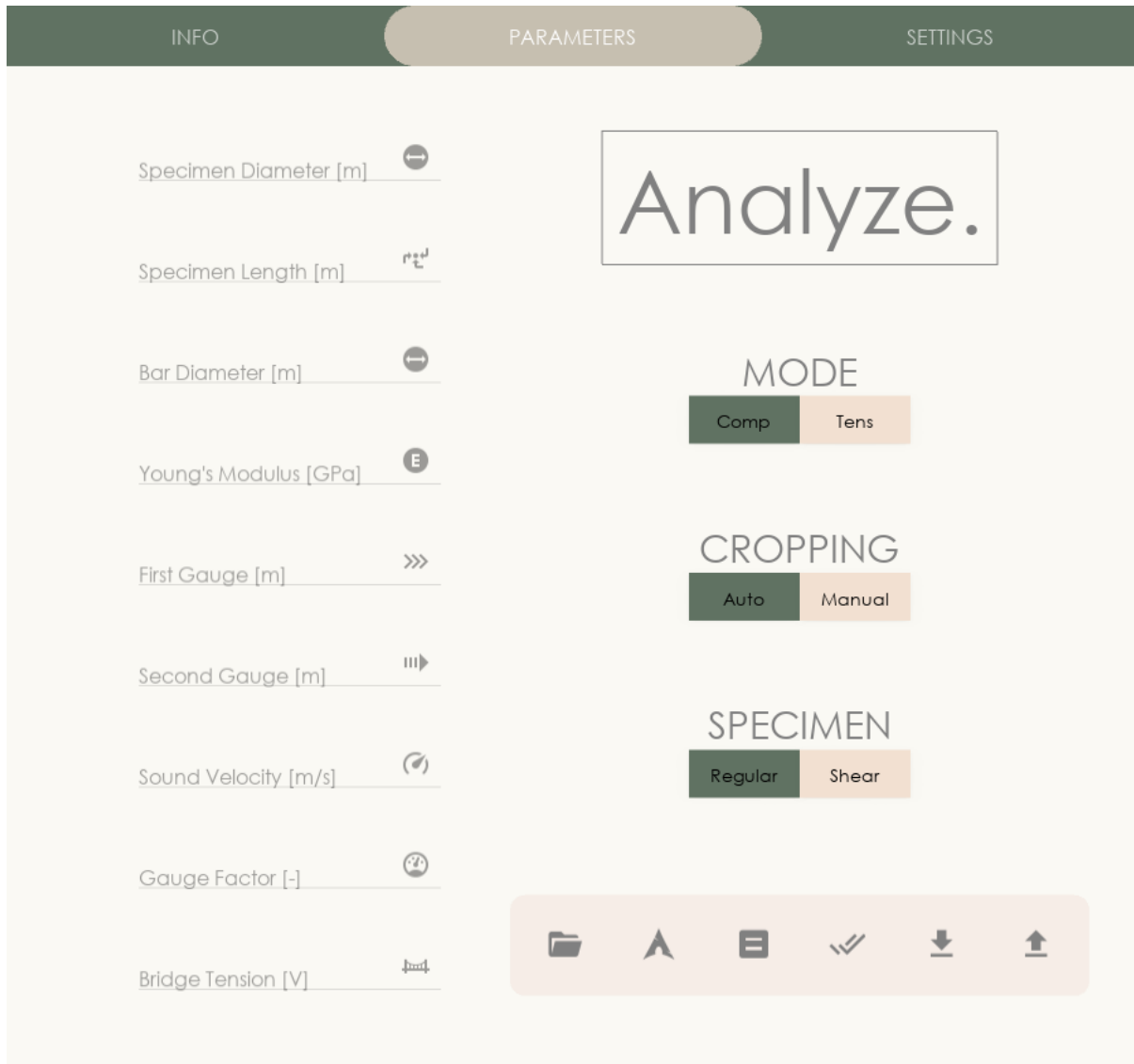
Here most of things occur. The **toolbox** – the wide bar at the bottom right will serve you in many ways, each described in the following sections.

Set Path Folder

Firstly, choose your path folder using the 'Set Path Folder' button found on the wide bar at the bottom right. A standard folder browser should open, and you will be able to choose your desired path folder (this is the folder you set up earlier in Preparing the Files section). Direct the browser to your file – ready path folder and click on "Select Folder". If your file preparation was successful, your path folder should now contain as much folders as experiments you made. Divided into experiments, your files are
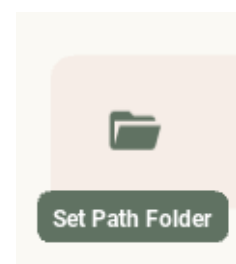
now named "incid" and "trans" respectfully (incident and transmitted).

Setting Numeric Parameters

The parameters on the left (specimen diameter, specimen length, etc.) are the ones that must be filled. They are your experiment system's and specimen's parameters and are unique to each experiment or laboratory. Once you click on one of the parameter fields you will be able to see what the default value for that parameter is (defaults to 0 on newly downloaded 2BarG programs) and input your value for this parameter.
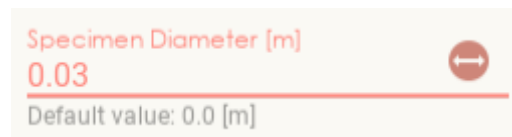
Enter the desired value <u>in the same units as mentioned</u> and **press enter** after **each** new added value.

Default values

Note that once you change the current value, the *default* value will *not* change. If a change in the default values is desired, a click on the "Set as Default" button in the toolbox will do:
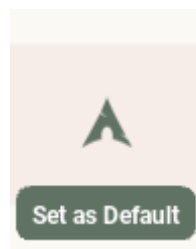
To display the current parameters' values, press the "Show Parameters" button on the toolbox:
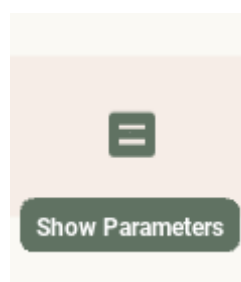
This will open a window with all the current parameters. If analysis is executed, these parameters will be of use. If the parameters are invalid, nothing will happen.
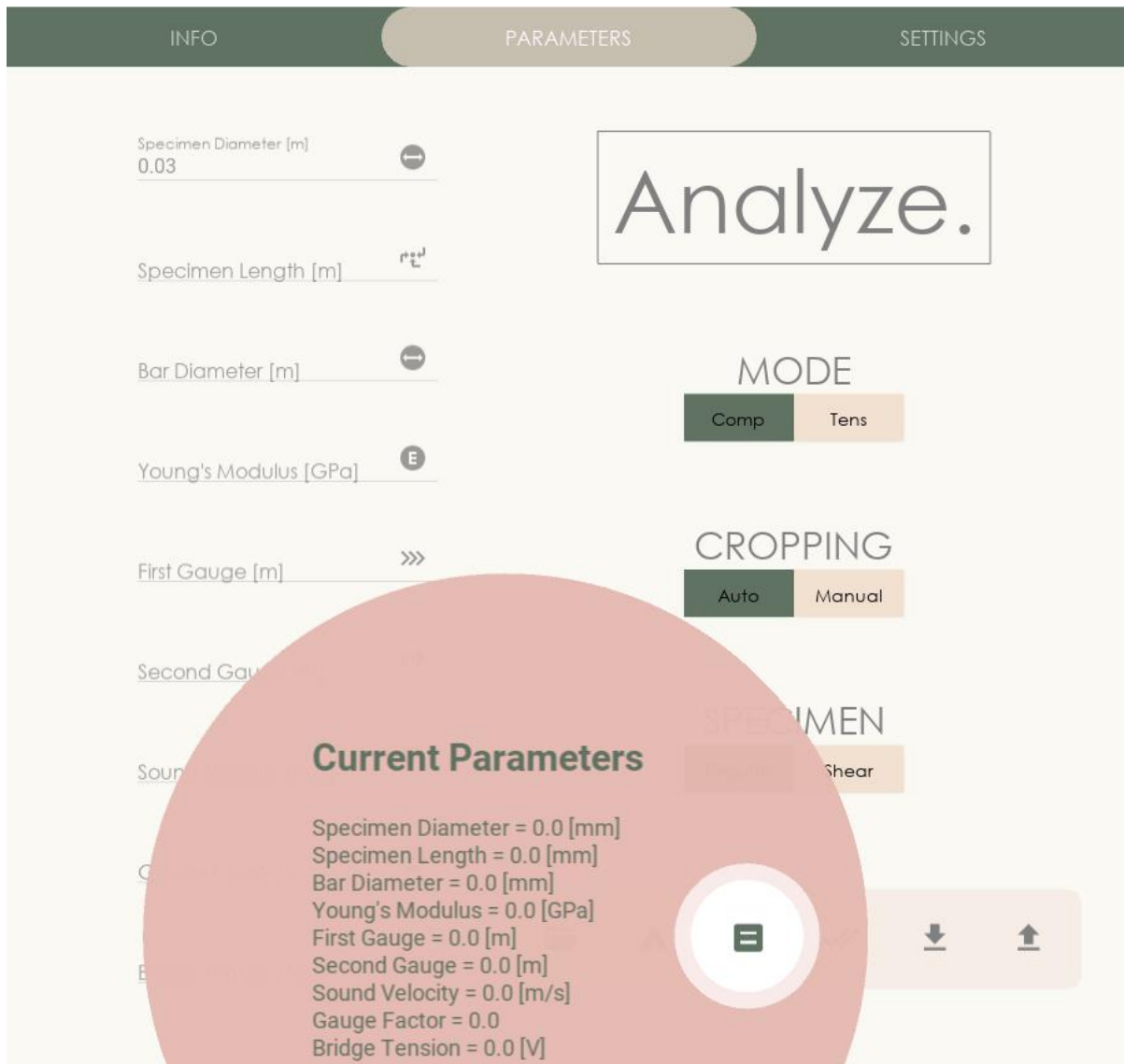
A simple click away from the now open bubble will dismiss it.

Parameter Presets

Presets can be saved and loaded with the two arrow buttons that can be found in the toolbox. The parameter presets are of a unique file type: *".twobarg"* to avoid confusion with any other files.
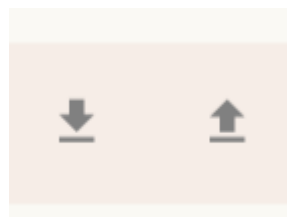
Experiment Modes

The next step toward data acquisition is setting up your analysis processing preferences.

The experiment "MODE" simply tells the program if your experiment was a compression (comp) or tension (tens) experiment.

The whole signal cropping process is discussed in *Signal Processing* and consists of two modes – automatic and manual. Cropping defaults to automatic, and if one desires to manually crop the signals, a click on the "Manual" button below "CROPPING" will enable to do so. See *Manual Cropping* for further details.

SPECIMEN mode will simply change what analyzed data comes out of 2BarG.

In **'Regular'** specimen mode the following will be obtained:

Raw Signals, (Dispersion) Corrected Signals, Stress – Strain curves, Forces, Velocities, Displacements.

In **'Shear'** specimen mode the following will be obtained:

Raw Signals, (Dispersion) Corrected Signals, Bar Strains, Forces, Velocities, Displacements.

Choosing Experiments (Analyze)

Everything should be set by now, so you can go ahead and choose your experiment with the **"Analyze."** button or analyze all your experiments using the "Analyze All Experiments" button in the toolbox (double V icon). Now a full report with your analyzed results and experimental data should open in your browser (or multiple reports if you chose to analyze all your experiments). Simultaneously, the same results that are visible in the report(s) are now available for usage in your path folder in CSV format files, each in its respective folder.

- Note that if you chose a shear specimen mode, the *Bar Strains* will not appear in the report. This is since the *Raw Signals* are already shown (these are the original experiment signals). The *Bar Strains* are proportional to the raw signals and thus there is need in showing both.

Although the reports are supposed to serve as a sanity check for your analyzed results, they are automatically saved in your path folder, in case you'll need to use them again.

This is it! By now you should have fully analyzed CSV files waiting in the experiments' folders, with an additional text file with all of the parameters used for the analysis, including a calculated *Average Strain Rate* (Also appears in the reports).

Signal Processing

Signal Cropping

A cropping is needed to be made for the final calculations and analysis. It is better to perform it at the beginning – there is no use wasting processing and analysis time on unneeded data pieces. The raw, original signal imported from the path folder has the general form as the following:
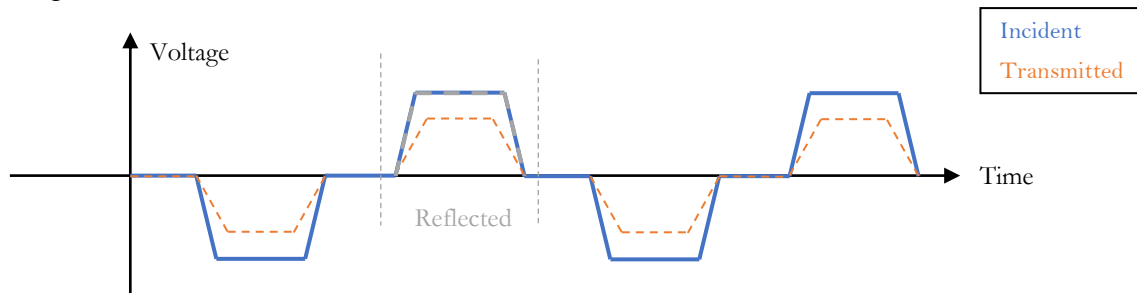
For the analysis, the first and second (reflected) incident waves, and the first transmitted wave are needed. For proper calculation and integration, a difference of amplitudes is needed. For this reason, we want to crop our original signals and re – arrange them on top of each other, as shown. This is the **cropping** process. One can perform the cropping manually or let 2BarG do it automatically.
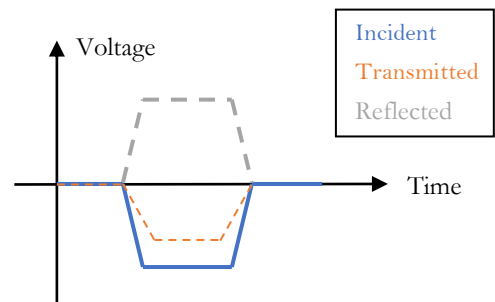

Manual Cropping

Change your cropping mode to Manual and choose an experiment (or analyze all of them). A figure including some instructions will appear, this is your *incident* signal. <u>Only</u> in the following order should one select the points:

1) Incident first wave's starting point.
2) Incident first wave's ending point.
3) Reflected wave's starting point.

Try to make the distance of the first point from the first peak the same distance as the third point's distance from the second peak ($\delta_1 \approx \delta_2$). To delete the last point you selected, simply press 'Backspace' on your keyboard. Once the selection is over, simply close the figure (it may shrink when you try to close it, another click on the X button should close it totally), and a new figure will appear, containing your *transmitted* signal.
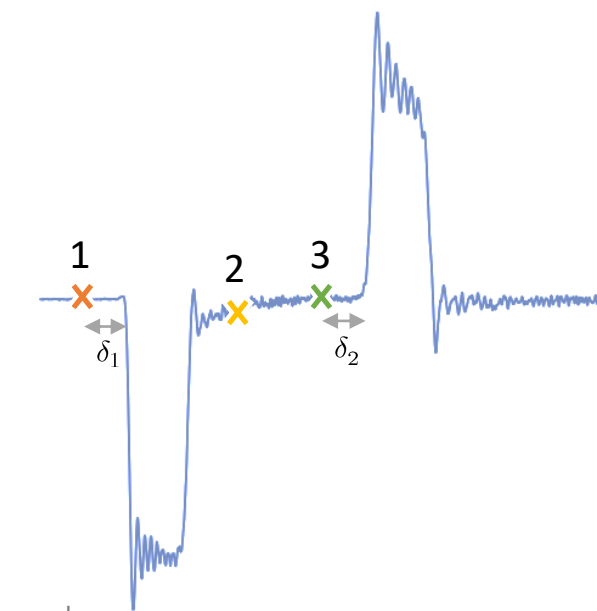
Select **only the transmitted signal's first wave's starting point** (just like point 1 in the incident signal, try again to select with a distance of δ_1) and again close the window(s).

Automatic Cropping

2BarG's automatic cropping uses peak finding algorithms to crop the signal. Since signals are usually noisy, a smoothing is applied to signals before looking for peaks. This smoothing can be controlled by the user with the *Curve Smoothing* slider in the '**Settings'** tab in 2BarG:
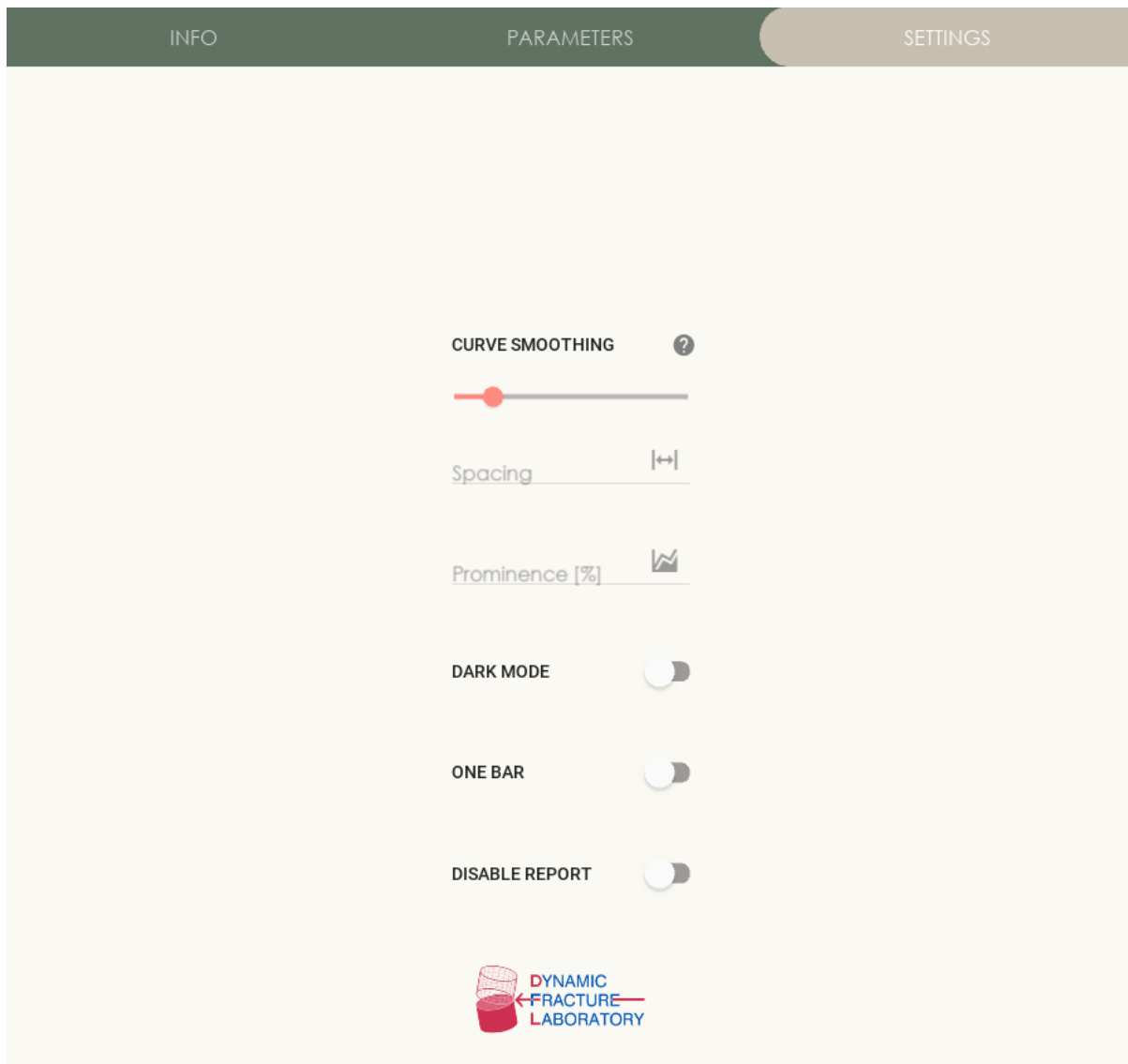

The smoothing helps finding the real peaks and is *not* applied to the original signal, or to any of the data that results from the 2BarG program.

Looking back at our signal, the peaks that are of interest to us are (1), (2) and (3):
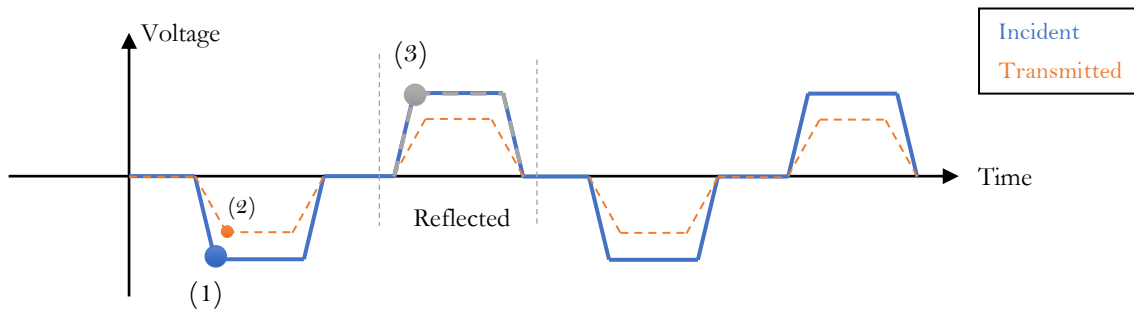

Meaning we take the first two peaks the algorithm gives us from the incident signal, and the first one

from the transmitted. Subsequently, the program will perform a search on the signal: going back and forward in time from each of the three peaks to find where the signal changes its sign and marking where that occurs (marked in 'X's in the figure below). These markers are where the signal needs to be cut.
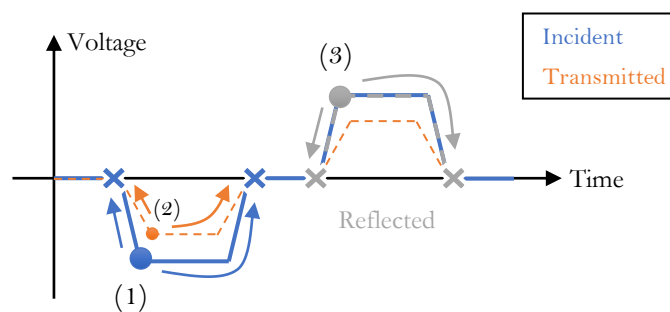
This is where the **spacing** parameter (that is also found in 2BarG's **Settings** tab) comes to play – it defines how far from these markers the cropping is actually done. If spacing is defined as zero, the waves will be cropped exactly where they start and end (the same X marks in the figure above). With some arbitrary spacing (which is not zero), the cropping markers will be set as shown in the following figure:
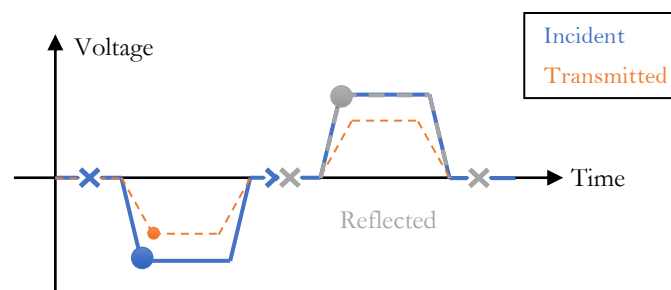
Results may vary slightly when picking different spacing, therefore it is an option available for the user to change.

Spacing is measured in point numbers (*not* in time), and defaults to 60 points.