

# **Python Analysis Program Documentation**

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## **Installation Instructions**

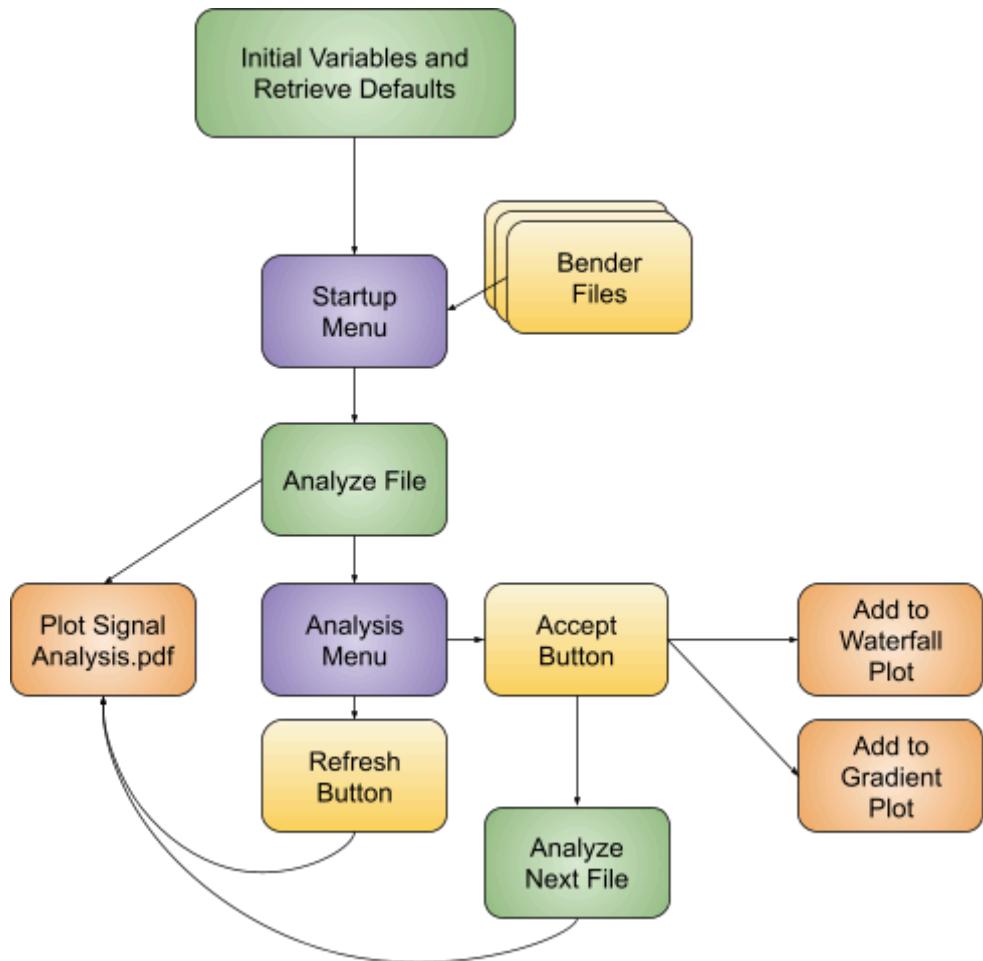
Download “BenderAnalysis\_X.X.X\_Windows\_Setup.exe” file and run it. This will open a setup wizard to install the software on your computer.

## **What files can be processed:**

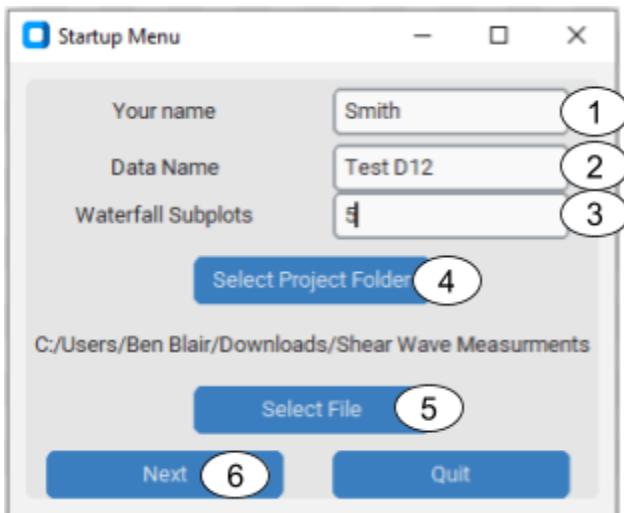
All selected files must either be “.bes” or “.txt” file format. Otherwise, they are removed from the selection.

- If “.bes” extension, the file must be organized with data starting after 14 rows and in column 2.
- If “.txt” extension, the file must be organized with data starting after 2 rows and in column 3.

## Menu Structure



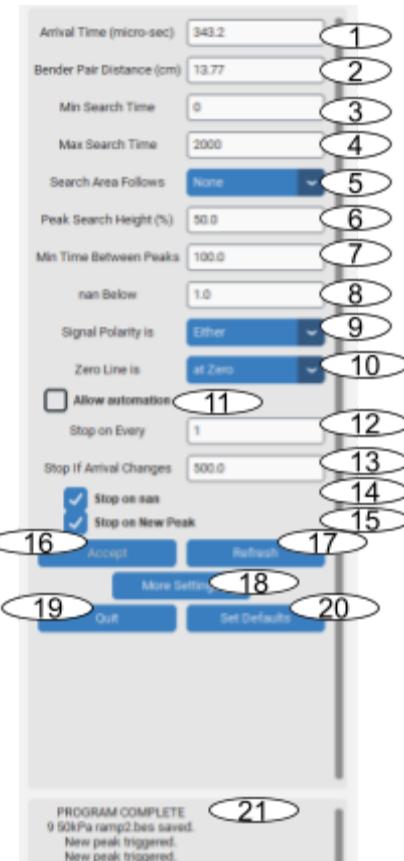
## Startup Menu



1. Operator's name
2. Test or analysis's name
3. Number of plots per figure.
  - a. Try not setting this over 20, as the waterfall plots have trouble fitting in the axis when there are too many.
4. Select the project folder
  - a. This is where the resulting excels, and plots will be saved.
5. Select files for analysis.
  - a. Currently, only 250 files can be processed at a time, assuming there is about 4G of available RAM.
6. The next button will only be active after the form is filled out.

## Analysis Menu

1. Arrival time in microseconds.
  - a. This is the time shown as the red line on the plot.
  - b. If you replace this value with a different time and hit accept, your arrival time will be saved as a manual time.
  - c. This may also show as nan if no arrival time was found.
2. Bender Pair Distance is where you add the tip to tip distance of your benders so shear wave velocity can be accurately calculated.
3. Min search time defines the minimum time that you expect to find the signal arrival.
  - a. The min and max search times help the algorithm to eliminate unshifted peaks from the search of the signal.
4. Max search time defines the maximum time where you expect to find the signal arrival.
5. Search area follows is a function that changes the min and max search times when you go to the next file based on how much the min or max peak of the file shifts. If it works, it captures the progression of a test and automatically moves the search area for you. Keep in mind it only works for cases where the arrival time is progressively shifting with each measurement, and the overall signal shape stays the same.
6. Peak search height sets the height that local peaks must reach to be considered as arrival signal. It is calculated as: 
$$\frac{h_{\max \text{ local peak}} + |h_{\min \text{ local peak}}|}{2} * P_{\text{percent peak search height}}$$
.
7. Min time between peaks is a parameter that removes peaks if they are spaced together tighter than “Min time between peaks”.
8. Nan below sets a minimum peak search height below which no signal is found. Since the search height for peaks scales with the local peak height, file analysis would always return peaks if no lower threshold is set.
9. The signal polarity dropdown only finds a signal with a particular signal polarity.
10. For algorithmic analysis, the arrival time is found as the intersection between the defined zero line and signal. The zero line dropdown allows the user to choose a zero line at zero, the average of the first bit of signal or a linear fit of the first bit of signal. If using a Butterworth filter, the signal is realigned to zero, so this menu should be set to “at zero”.



### *Automation*

Automation functions try to allow for bigger data sets to be efficiently analyzed by automatically clicking the accept button when conditions are met. See the “data processing strategies using automation” section for more information.

11. The automation checkbox enables/disables automation.
12. Stop on every set a stop on every nth file.
  - a. It is not conditional on what file you are on. For example, you are analyzing file 7, you set stop on every equal to 15. It will analyze all files until it reaches file 15, not file 22 ( $15 + 7$ ).
13. Stop if arrival changes is triggered if the arrival time changes more than what is set.
14. Stop on nan, stops if a file arrival is not found.
15. Stop on new peak keeps track of the number of local peaks (min and max combined) in the previous file and stops if it changes.

### *Buttons*

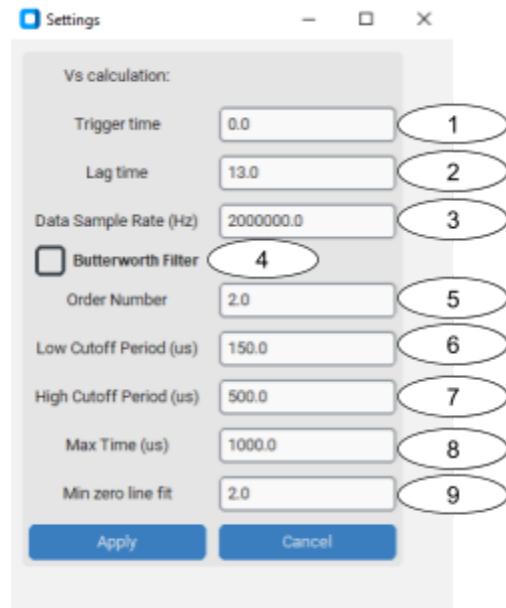
16. The accept button saves the current file and moves on to analyzing the next one.
17. The refresh button reloads the analysis. Perform this after the settings are changed.
18. More settings opens a menu with more settings, see more settings menu.
19. The quit button closes the program.
20. The save defaults buttons saves current settings that are automatically loaded when the program is reloaded.
21. This gives a readout of analysis notes.

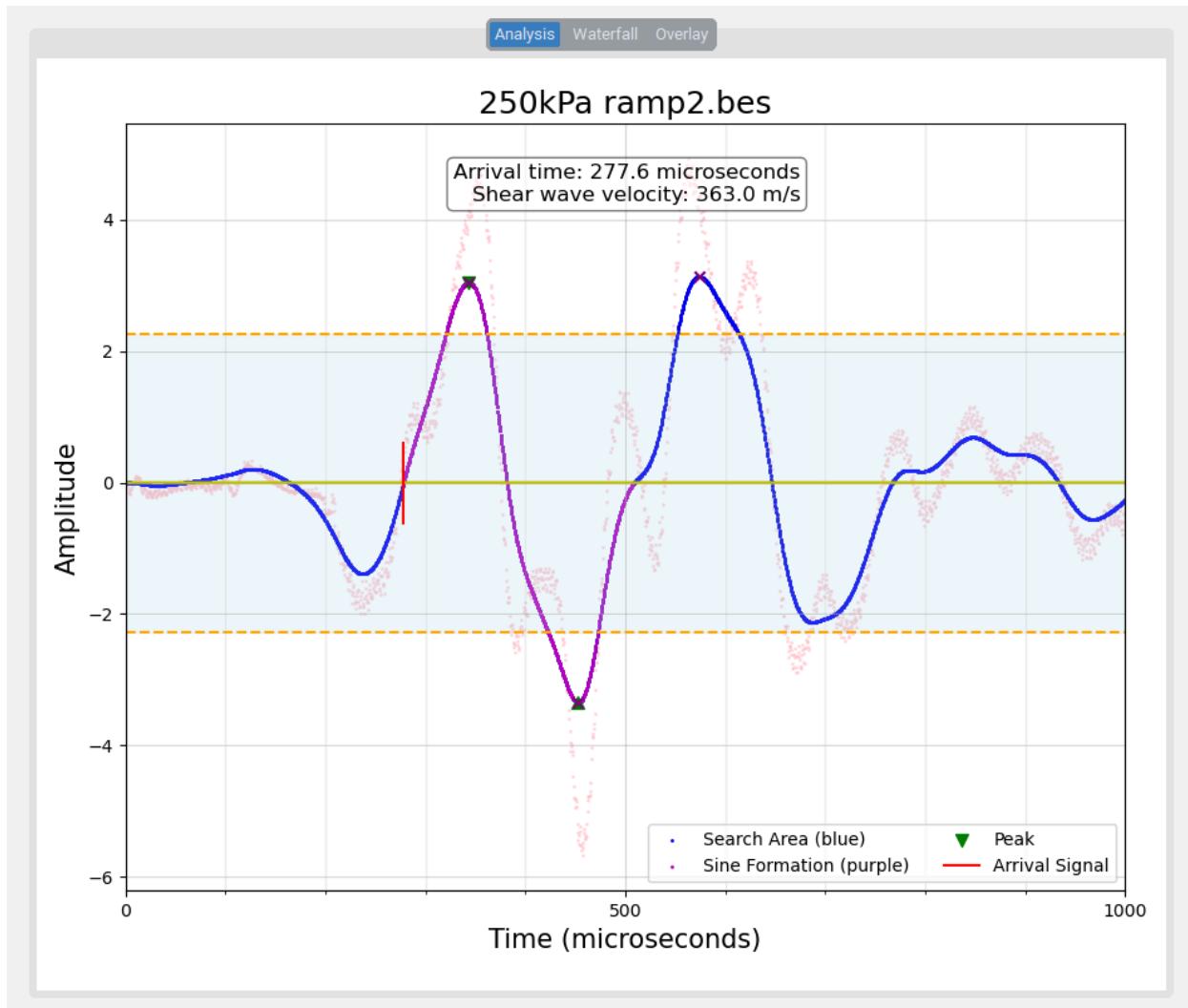
## More Setting Menu

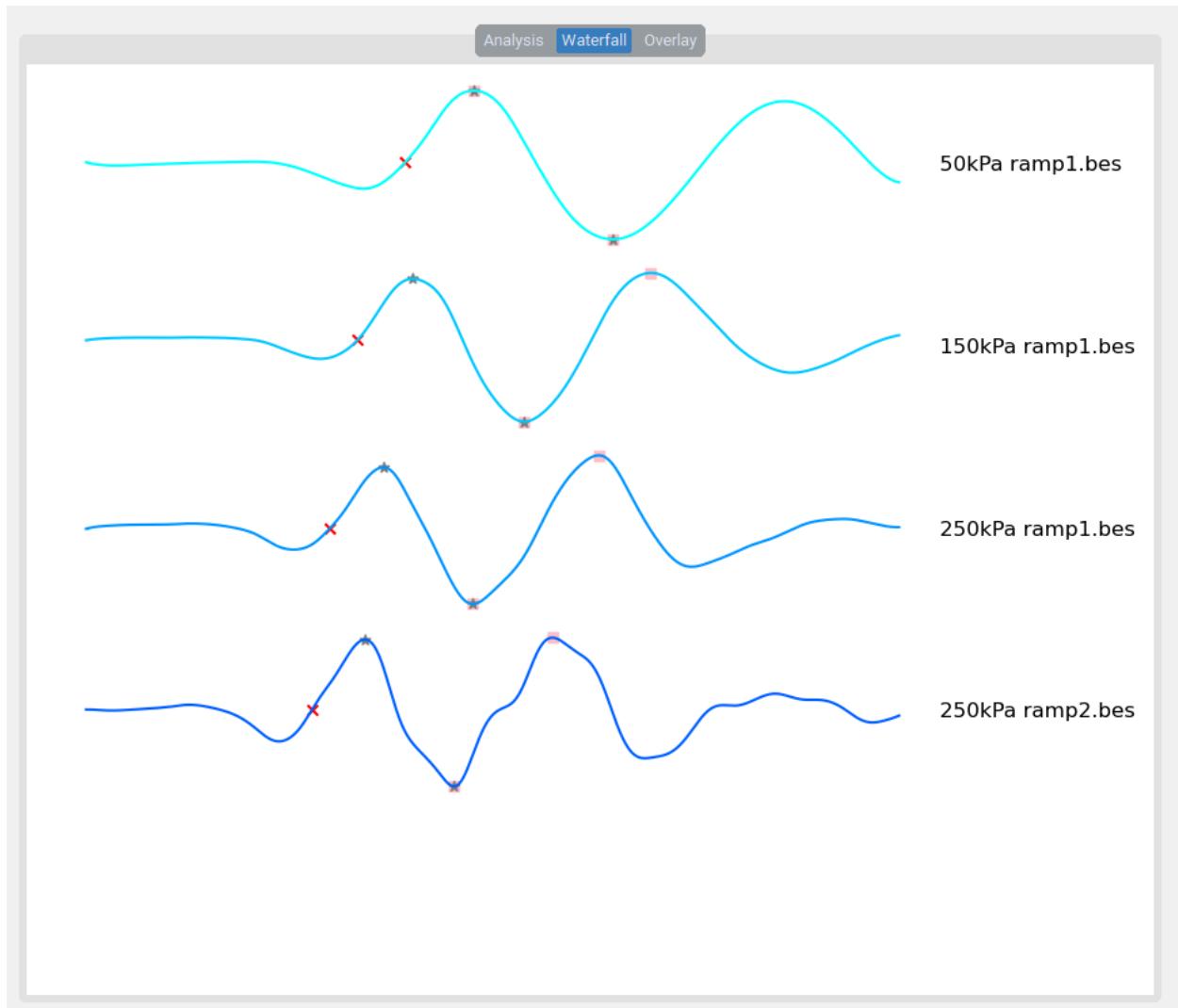
### *V<sub>s</sub>* calculation

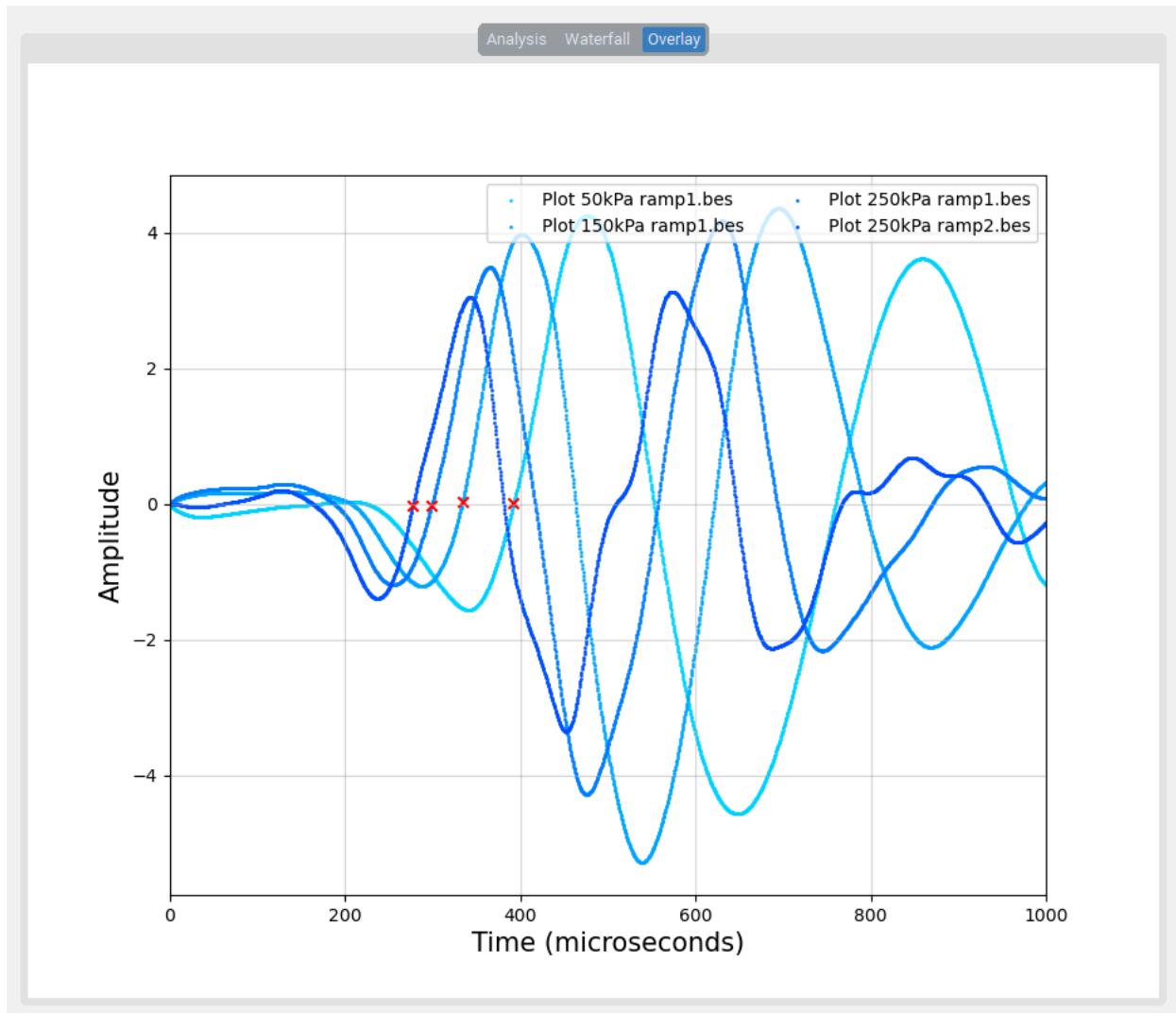
$$V_s = \frac{\Delta L}{\Delta t} = \frac{L_{\text{bender pair distance}}}{t_{\text{arrival time}} - t_{\text{trigger time}} - t_{\text{lag time}}}$$

1. The trigger time is subtracted from the arrival time when calculating V<sub>s</sub>, since some systems measure from different starting times.
2. Lag time accounts for system lag. This can be calibrated by performing tip to tip measurements.
3. The sampling rate of the measurement system.
4. Enable/disable the butterworth filter.
5. Order number is a parameter of the butterworth filter.
6. Lower cutoff period is the smallest period you want to keep.
7. High cutoff period is the largest period you want to keep.
8. Max time adjusts the max time displayed on the analysis plot.
9. Min zero line sets the minimum time that the zero line is calculated from.









### **Data processing strategies using automation:**

One analysis method could be to process all benders and then look through the waterfall plots for benders that were incorrectly analyzed. After analyzing the files, you can go to the spreadsheet and set files in the automation column to either “yes” for automate, “no” for don’t automate, or “manual” for manual arrival time. Setting the tab name to “Data” will allow the program to identify that this is the previous data and upload settings used for each file if automation is “yes”. Then when you reanalyze all the files again, you can stop at just the problematic ones.

### **Conditions to automate:**

If automation conditions are met, the next file will automatically be processed without the user clicking the accept button.

Allow automation button = yes

- a. Existing file specifies automate = yes or file does not exist.
  - i. File must be called “Bender\_Analysis\_Summary.xlsx” and have a tab called “Data”.
  - ii. The automated column needs to say “yes”, “no”, or “manual”
- b. Signal conditions = yes or not selected
  - i. Stop on every = (condition not met)
  - ii. Set to a high number (i.e 10000) if you don’t want it to trigger
  - iii. Stop if arrival changes = (condition not met)
  - iv. Set to a high number (i.e 10000) if you don’t want it to trigger
  - v. Stop on Nan = (condition not met) or box not checked
  - vi. Stop on New Peak = (condition not met) or not checked
  - vii. Will always stop if
  - viii. Arrival time is less than the min search time
  - ix. Zero line and data don’t intersect

**Conditions to return Nan:**

Can’t find a positive and negative peak.

Can’t find intersection between zero line and plot.