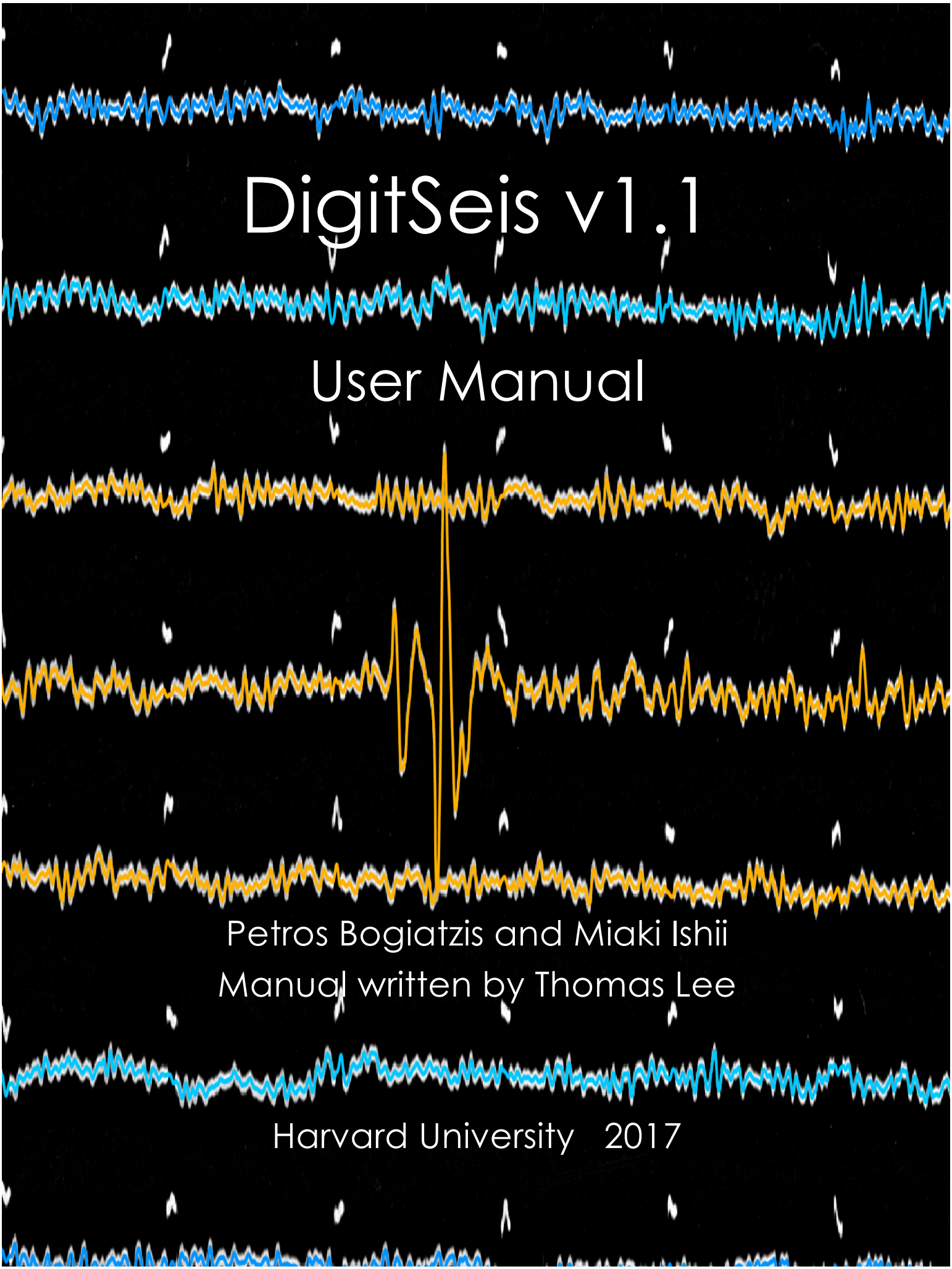

DigitSeis v1.1

User Manual

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Harvard University 2017

For more information please visit
www.seismology.harvard.edu

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Table of Contents

Introduction

DigitSeis is a MATLAB based software that converts raster images of analog seismograms to usable digital time series in either the SAC or .MAT format. Essentially, DigitSeis identifies traces on an scanned analog seismogram and processes them by correcting for distortion and synchronizing traces with time offset marks. Where it is possible, DigitSeis uses automated image-processing algorithms to extract data, however, it still requires human input and supervision for the purposes of correction and monitoring.

Please note that DigitSeis is optimized for use with seismograms that include timemarks and were generated without a pen (i.e., no curvature perpendicular to trace zero line). The behavior of DigitSeis is not well constrained or tested for pen-generated or seismograms without. However, work is being done to add these capabilities for future releases of DigitSeis.

This manual provides the basic tools and functions of DigitSeis version 1.1. Description and instruction for additional tools and functions can be obtained from the authors. Changes from the previous version are documented in DigitSeis.readme file (plain text file).

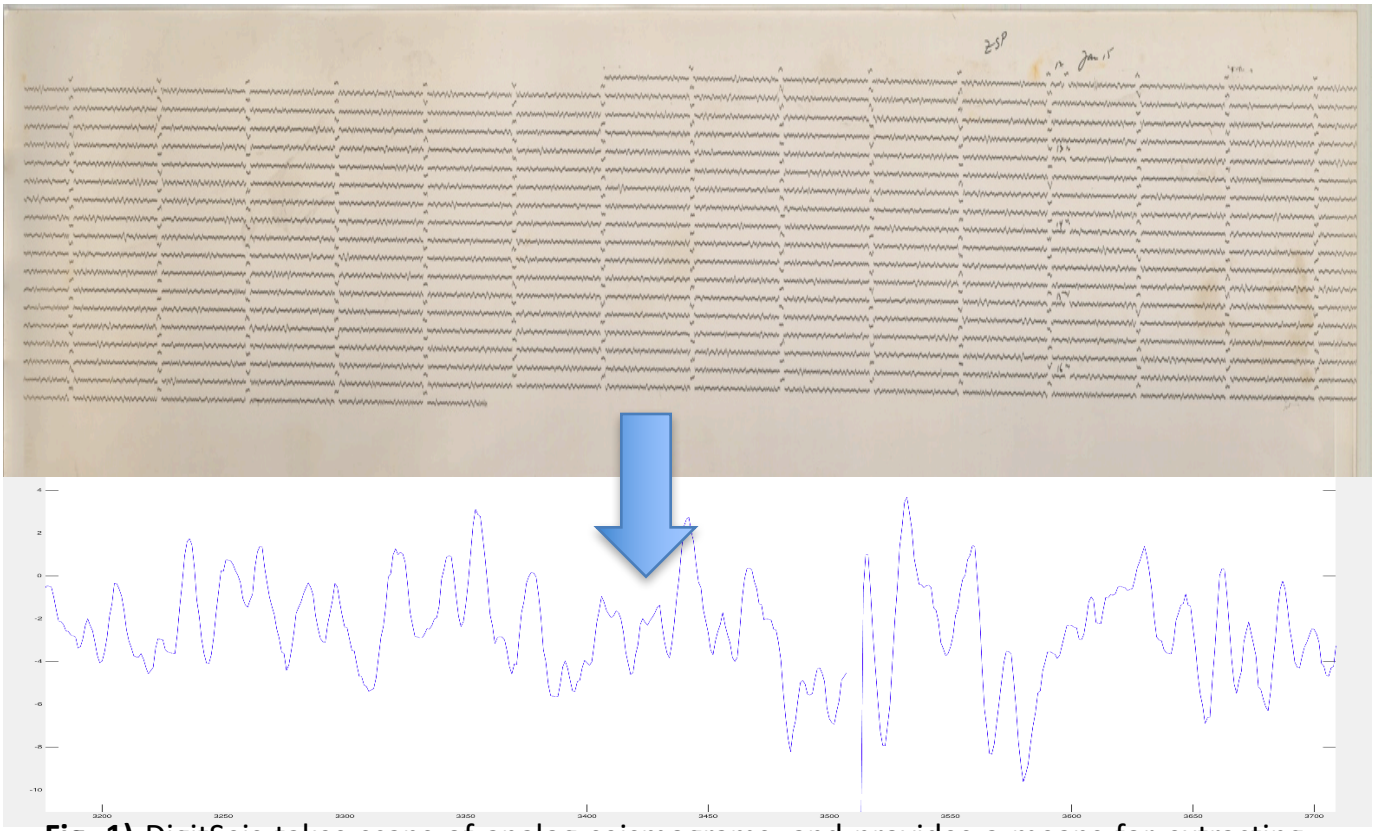


Fig. 1) DigitSeis takes scans of analog seismograms, and provides a means for extracting usable modern digital time series data.

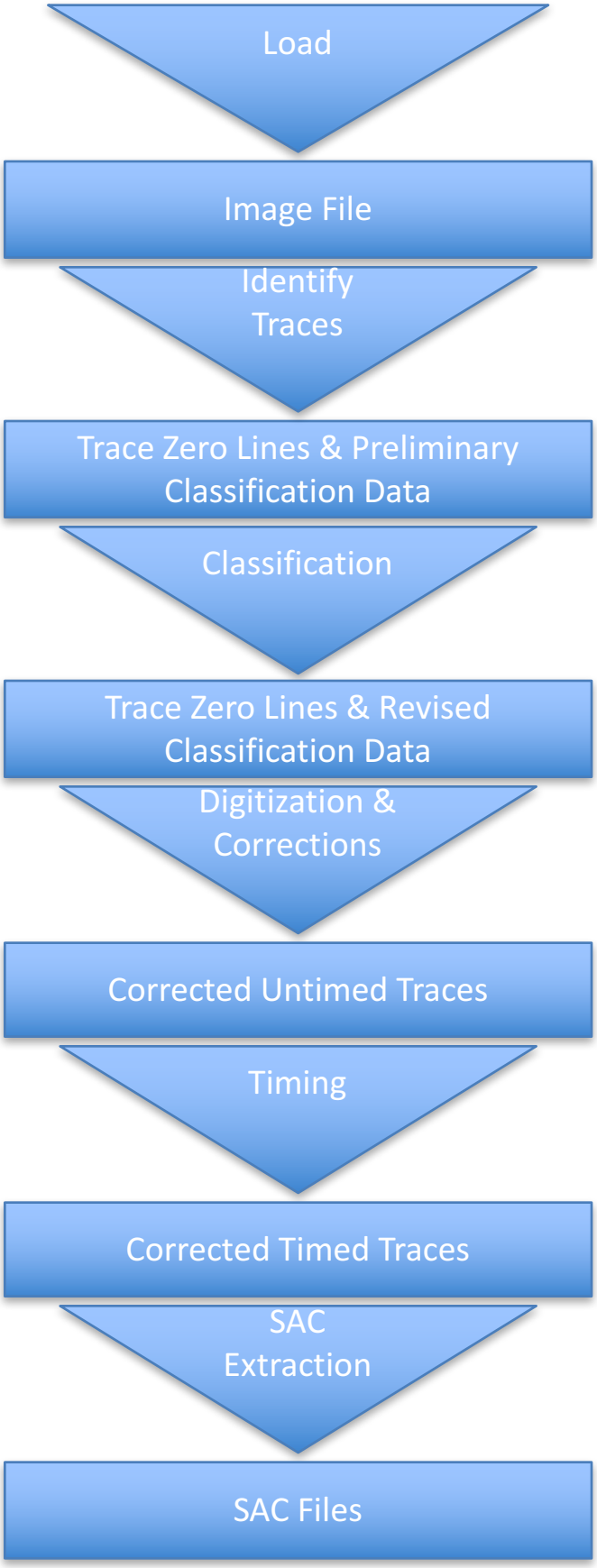
Overview of Digitization Process

The Digitization process can be separated into the following sequence of events: Image Loading, Image Pre-Processing, Trace Identification, Classification, Digitization, Trace Correction, Timing, and SAC Extraction.

- Image Loading is the initial reading in of an image into MATLAB. DigitSeis can accommodate all the image formats supported by the R2015b version of MATLAB.
- Image Pre-Processing is the set of steps which help to clean up the image and eliminate stains and unnecessary objects. This helps the digitization algorithm to run more efficiently.
- Trace Identification is where the program will look at areas of contrast (light vs. dark) to identify the position of the traces.
- Classification separates and identifies objects as either the main trace, time marks, or noise.
- Digitization takes the information from the Trace Identification and Classification steps and uses this information to automatically digitize the traces to the greatest extent possible.
- Trace Correction allows the user to manually digitize parts of the trace that could not be digitized automatically or that were digitized incorrectly.
- Timing uses the positioning of objects identified as time marks to interpolate the timing of the seismogram.
- SAC Extraction is the final step that allows the user to export SAC files of the data.

The sections of this manual are organized such that each of the following sections corresponds with one of these significant steps in the digitization process. Also note that the work can be saved at any time in the MATLAB's native .mat format.

Flow of Information Thru DigitSeis



Getting Started

DigitSeis is a MATLAB based software and has been extensively tested on version R2015b (DigitSeis has not been tested on versions above R2015b, and it is not known how changes between the versions will affect DigitSeis).

Download DigitSeis version 1.1 from

http://www.seismology.harvard.edu/research/DigitSeis.html

and untar the files. You will also need to to obtain the rgb2hsv_fast.m file from:

http://www.mathworks.com/matlabcentral/fileexchange/15985-fast-rgb2hsv/content/rgb2hsv_fast.m

and the writesac.m file from

http://ds.iris.edu/ds/nodes/dmc/forms/sac/.

These two other files should be placed in the same directory as the rest of the DigitSeis files.

To initialize DigitSeis, first open MATLAB and navigate to the DigitSeis.v.1.1 folder. Once the DigitSeis folder is your working directory, simply type “DigitSeis” in the command line and the program will initialize (Fig. 2).

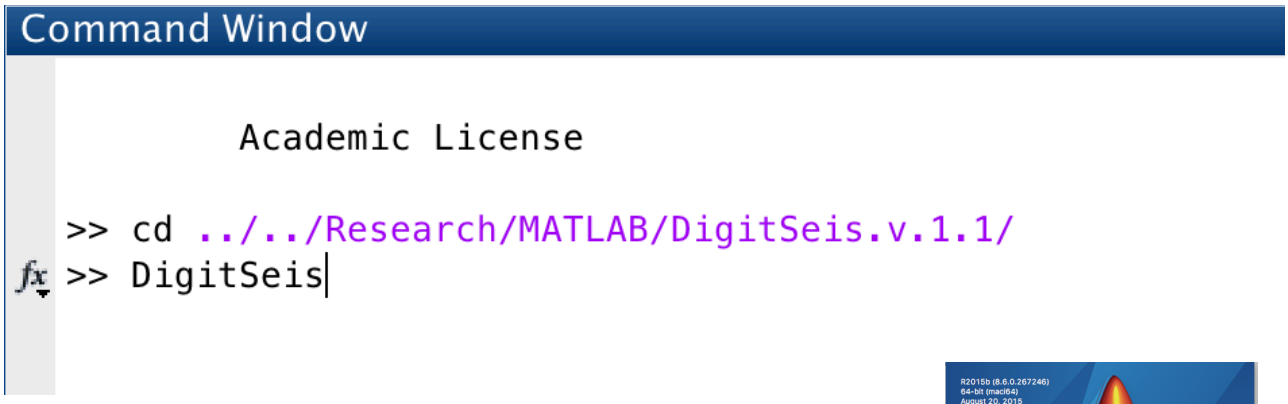


Fig. 2) To initialize DigitSeis, navigate to the DigitSeis.v.1.1 folder using the command line (the MATLAB Command Line takes UNIX basic commands such as: cd, ls, etc.) and then type ‘DigitSeis’.

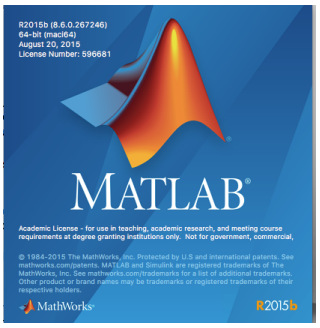


Image Loading

After DigitSeis initializes, the program will give the options of either loading an existing saved analysis or loading a new image (Fig. 3). For the purposes of this walkthrough we will start with a new image. In the future, loading a saved analysis will return to the stage of digitization where the analysis was last saved.

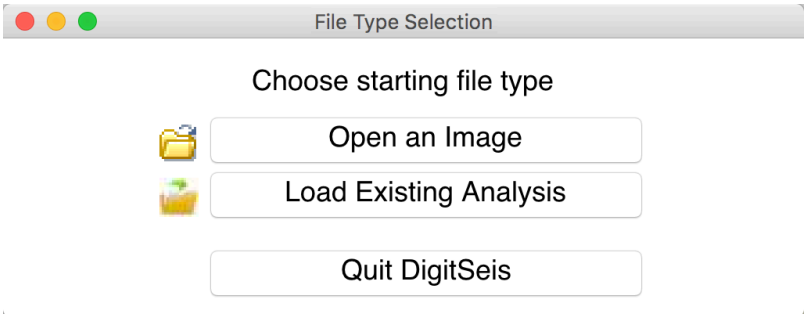


Fig. 3) This is the opening prompt for DigitSeis and is what the user should see after typing 'DigitSeis' in the Command Line

When the option of loading a new image has been selected, the program will prompt the user to specify the location of and select the image. Once this has been done, the program will automatically begin reading in the image.

As the image is loaded, the user will be asked if DigitSeis should consider the complement of the image that has been input (Fig. 4). Once loaded into the working environment, the traces should be light over a dark background. Therefore, if the image has dark traces over a light background, the user should instruct DigitSeis to consider the image complement, on the other hand, if the original seismogram was of the sooted variety with black background and white traces, this is not necessary.

Note that for loading a large image will take time. A typical image from the HRV station (52.7MB, 43500x17000, JPEG) takes about 75 seconds to load on a machine with 16GB RAM.

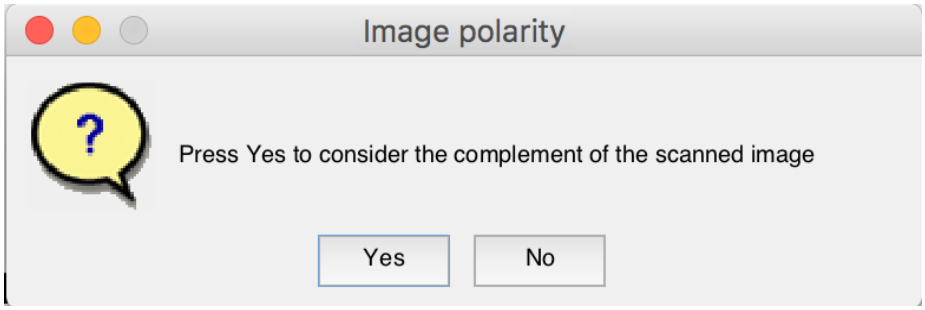
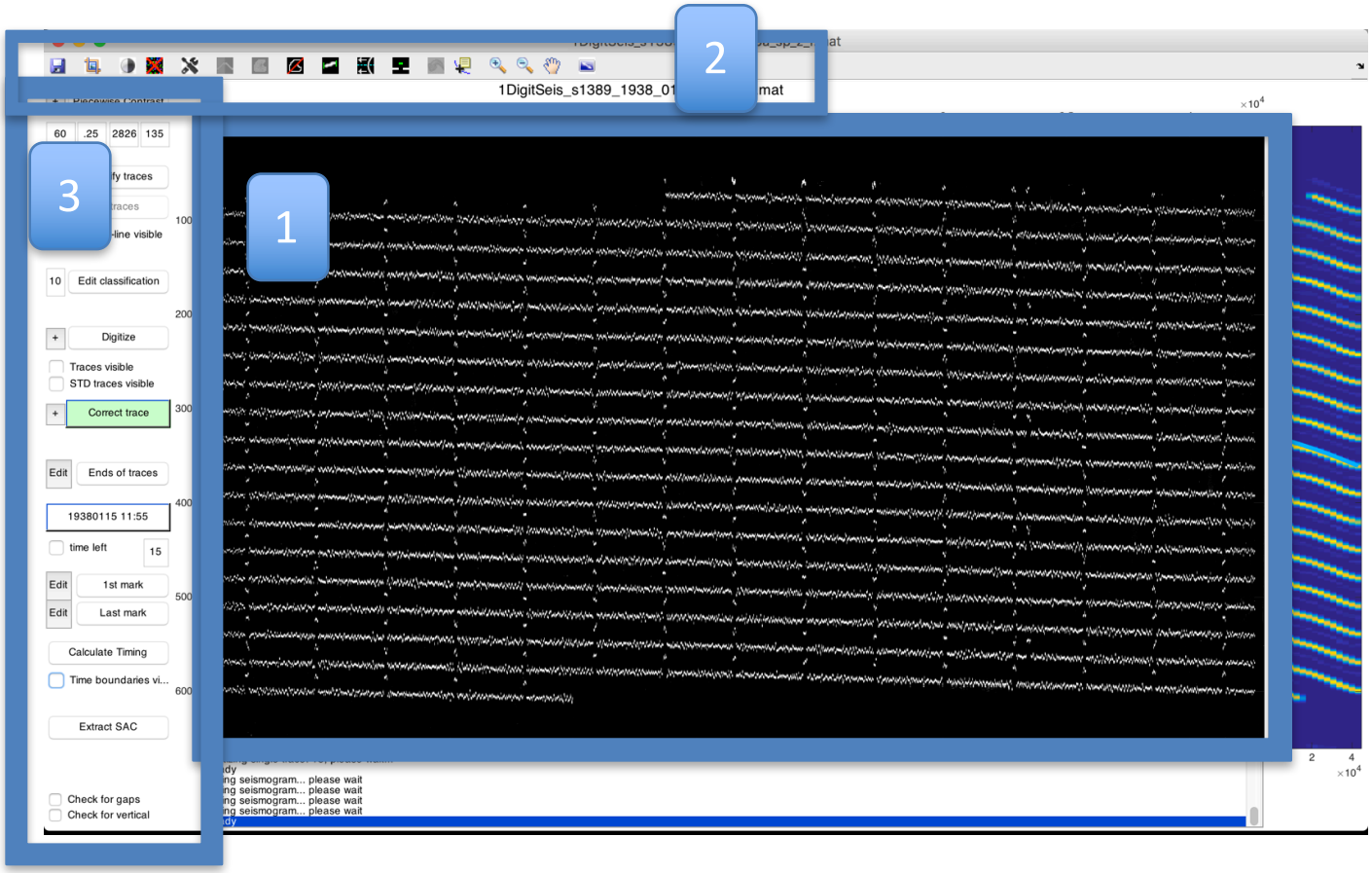


Fig. 4) Here the user should select an option based on the original format of the image – dark traces on a light background, or light traces on a dark background.

General Layout of DigitSeis

After the image has loaded, the DigitSeis working screen will load (Below).



The main components of the window are:

1. The Main Window: Here the image itself is displayed. Changes made as the user goes through the digitization process will be reflected in this window.
2. The Toolbar: The buttons which access many of the tools for image editing and controlling what is shown in the Main Window can be found here (for more detail, see page 10)
3. The Left Sidebar: As the process of digitization progresses, the user will work from the top to the bottom of this sidebar. The main functions found here are organized chronologically to reflect the order in which these steps should be taken. (for more detail, see page 11)

Note: For easy reference, you can find the layouts of the Toolbar and Left Sidebar (along with other toolbars) in Appendix A of this manual.

General Layout of DigitSeis

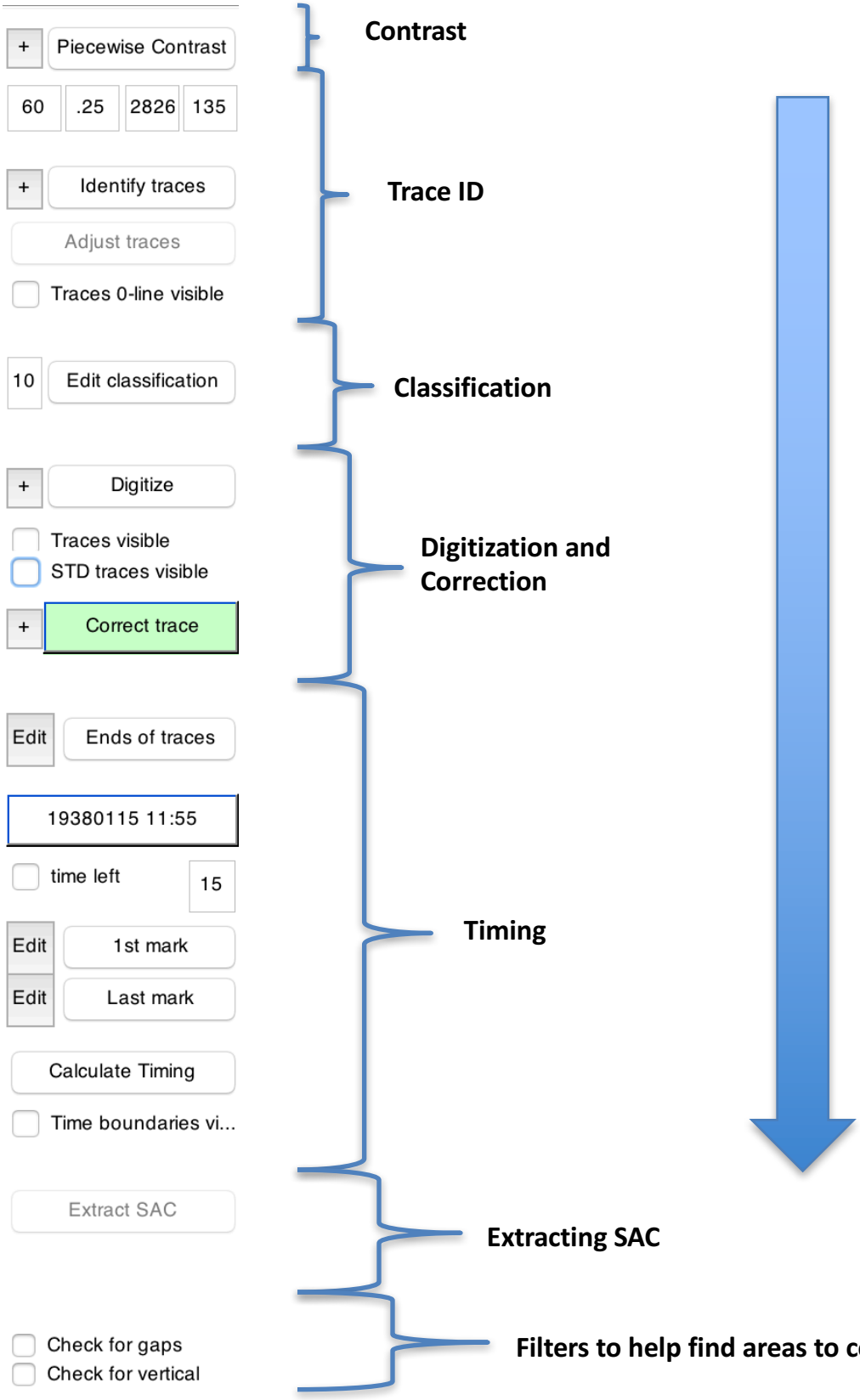
The DigitSeis Toolbar

From left to right:

- Save Files
- Crop Image
- Adjust Contrast
- Remove Salt and Pepper Noise
  - Can be used to remove spotting on the image (many small dots will be classified as noise and slow down the program).
- Edit Image
  - Can be used to access to select small region and process the region for better image quality.
- Toggle Original Image
  - Switch between the original image and the version where changes have been made.
- Recover Region
  - Recover regions from the original image and apply to the working image.
- Remove Region
  - Remove a region of the working image.
- Measure Tick Length
- Curvature
- Timemark Position
  - Select this option to make sure that the position of the time mark (green segment) of the icon is consistent with the actual image.
- Undo
- Add Data Cursor
- Zoom In
- Zoom Out
- Move
- View Whole Image

General Layout of DigitSeis

The Left Sidebar

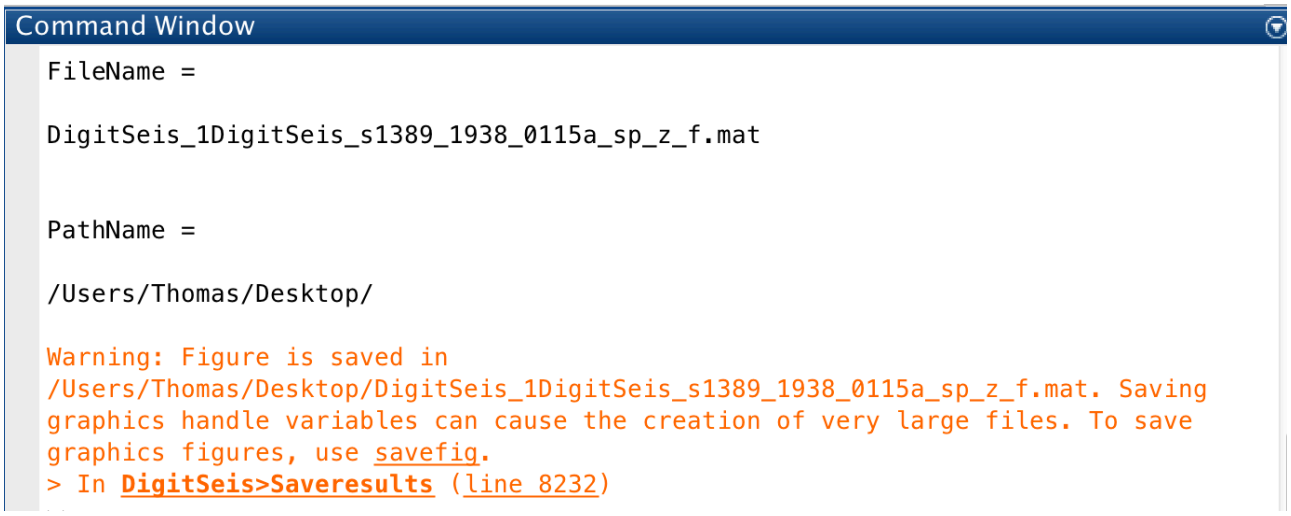


The Left Sidebar will populate with options which can be selected as the analysis is completed. That is, as the user works through the steps outlined in this manual, they will work from top to bottom with regard to this panel. This panel also includes many '+' buttons which allow for more control over the algorithms (See *Appendix B: Increased Controls)*

Saving Analyses

At any point in the digitization process, the analysis can be saved as a .mat file. Doing this allows the user to choose the "Load Existing Analysis" option upon startup and pickup where they were when the analysis was saved.

To perform an intermediate save (as opposed to extraction of SAC files, covered later in this manual), the user should select the Save button from the DigitSeis toolbar and simply select the location for the .mat file to be saved to and hit ENTER. The following message should be displayed in the MATLAB Command Window.



Important places where it is suggested that the user save the analysis are:

1. After loading the image
2. After identifying traces
3. After Classification
4. After Digitization
5. After Trace Corrections
6. After Timing

Keep in mind that these are simply suggested save points and that the analysis can be saved at any point (e.g., partway through the classification process).

Image Pre-Processing

Once the image has been successfully loaded, often, it requires some processing for optimal digitization.

There are various options for image pre-processing, but for a clean image, cropping the area of interest, and running piecewise contrast should be sufficient. For additional functionalities, see Appendix B.

Cropping

Most images will have a lot of blank space around the edges which contain no data. These areas can be cropped to save the computer the work of having to consider areas where there is no data. This can be done using the Crop tool in the toolbar.

Crop Tool

To use the Crop tool, click the on the Crop tool icon, wait for the cross cursor to appear and then drag the mouse to select the region to be digitized. The selected rectangle can be modified after the mouse button is released by moving the sides or the corners. To crop this region, double-click on the box (Fig. 5).

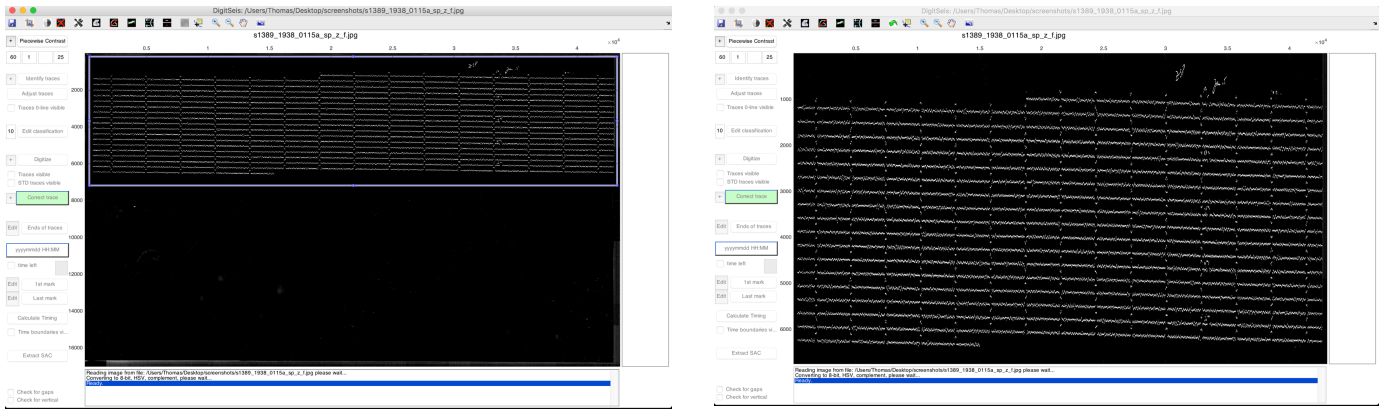


Fig. 5) Left: Using the box to select the cropping region. Right: The resultant cropped image.

Image Pre-Processing

Contrast

Images typically do not have even contrast throughout. This can cause issues during the classifications step. Use the Piecewise Contrast button located in the left command column (Fig. 6). In the ideal case, the image should have white or bright gray traces and as dark of a background as possible (Fig. 7).

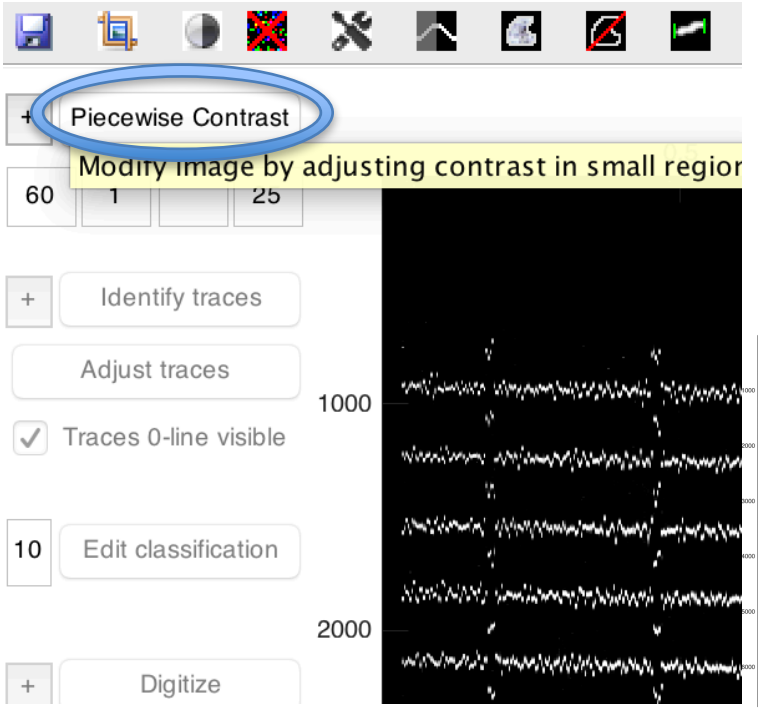
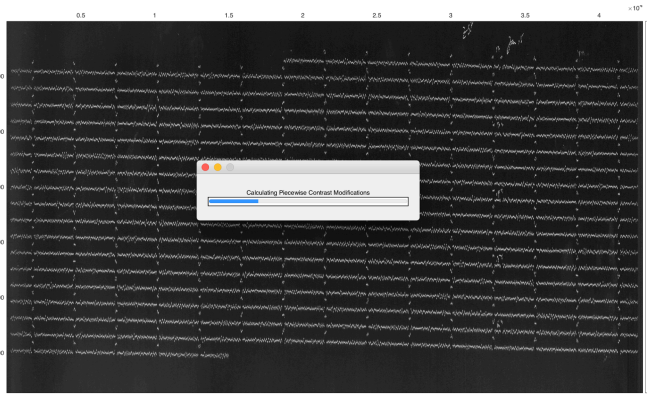


Fig. 6) Using the Piecewise Contrast button as shown on the left will initiate the automated contrast adjustment function. The algorithm's progress is indicated by the pop-up progress bar (shown below) which will disappear when the process is complete.



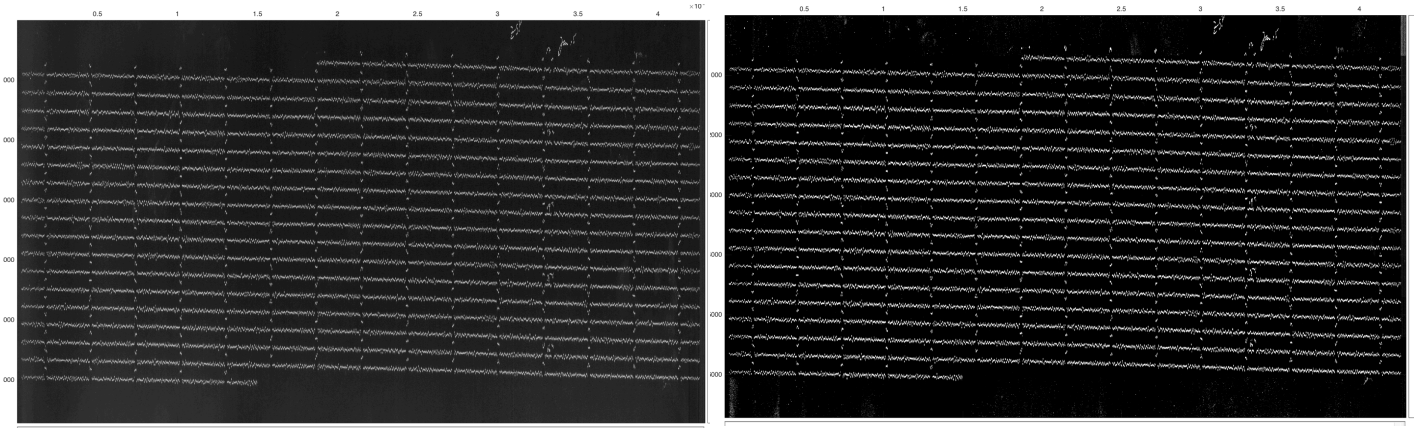


Fig. 7) Shown on the left is the image before the Piecewise Contrast function has been run, while the image on the right shows the cleaned image after the function has run. Note the increased contrast between the traces and the background in the image on the right.

Trace Identification

Once the image has been optimized, the next step is to input seismogram-specific information to the four boxes below the Piecewise Contrast button.

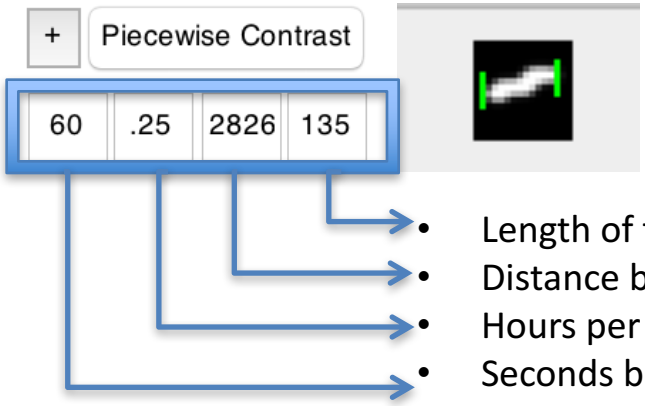


Fig. 8) The trace parameter information boxes located in the Left Sidebar, and the Measure Tick Length Button located in the toolbar

To obtain pixel numbers, use the Measure Tick Length function. To do this, select the Measure Tick Length button from the toolbar (Fig. 8), move the mouse over to the starting position, and then click and drag to the end position (Fig. 9).

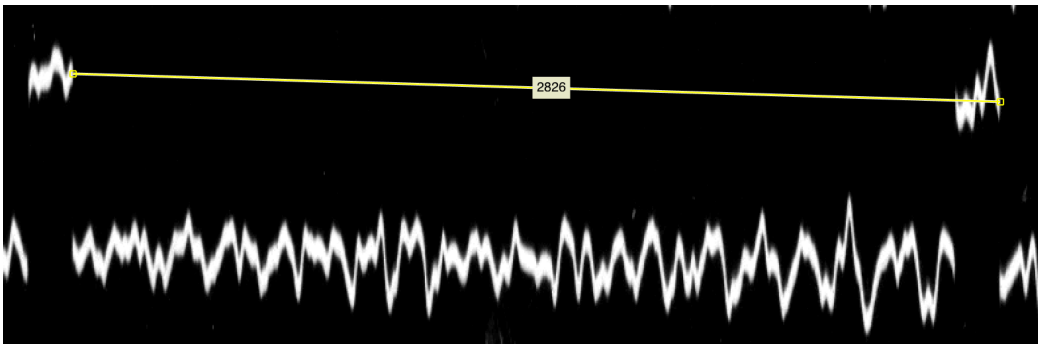


Fig. 9) Using the Measure Tick Length function to measure the distance between two time marks. This can also be done to measure timemark length.

After this has been done, press the Identify Traces button. When this button is pressed, DigitSeis will detect the number of traces and estimate the trace zero-lines (Fig. 10).

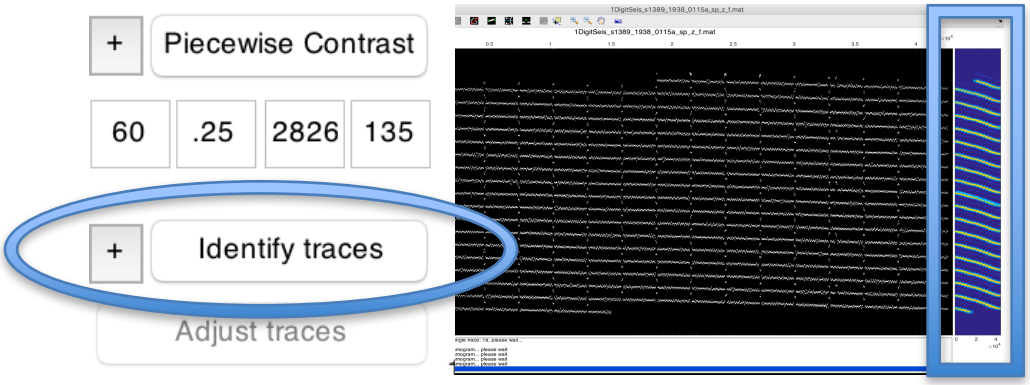


Fig. 10) After pressing the Identify Traces button (circled), the program will calculate the zero lines and populate the horizontal distortion plot on the far left of the working environment.

Trace Identification

If the trace zero lines calculated by DigitSeis need to be adjusted, use the Adjust Trace function in conjunction with the Data Cursor tool to edit the initial X and Y coordinates of the traces.

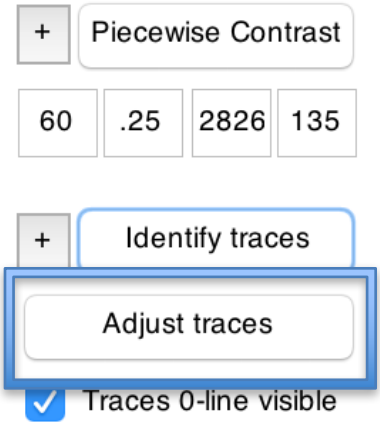
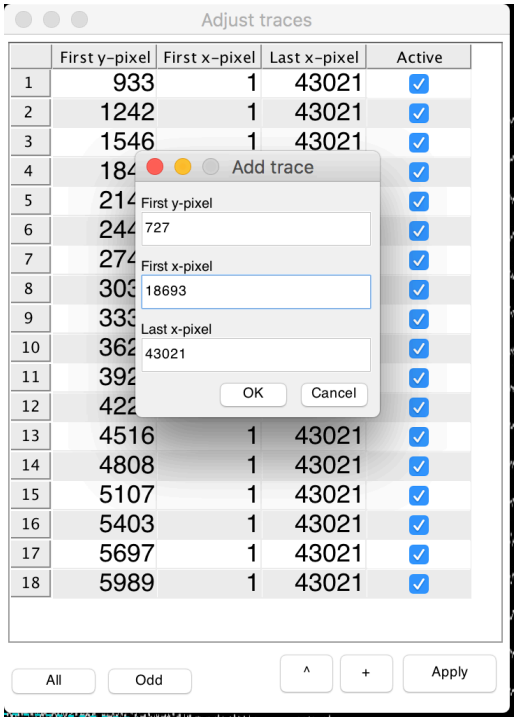


Fig. 11) The Adjust Traces button from the left sidebar (left). The Adjust Traces window allows user to modify the trace zero lines and add new traces (right).



If DigitSeis has incorrectly determined the number of traces, traces can also be added or deleted within the Adjust Trace window (Fig. 11). The layout of the columns in the Adjust Trace window is as follows: (from left to right) Trace Number, Starting y-pixel, Starting x-pixel, Ending x-pixel, and a check box for whether or not the trace is active. Note, that only the first y-pixel is necessary, whereas both first and last x-pixel values are needed. To delete a trace simply uncheck it and use the Update Traces button. If a trace needs to be added, use the + button within the Adjust Traces window. This brings up an Add Trace window where the required values can be input. The initial X and Y pixel values can be determined using the Data Cursor tool in the toolbar (Fig. 12). After selecting the Data Cursor button, the user should click the point on the image whose coordinates they want displayed. To remove the data point, simply right click and select 'Delete'.

In the case that the location of the trace zero lines needs to be modified, the values for an individual trace can be modified, or in the case that all traces need to be offset by a certain value, the ^ button can be used.

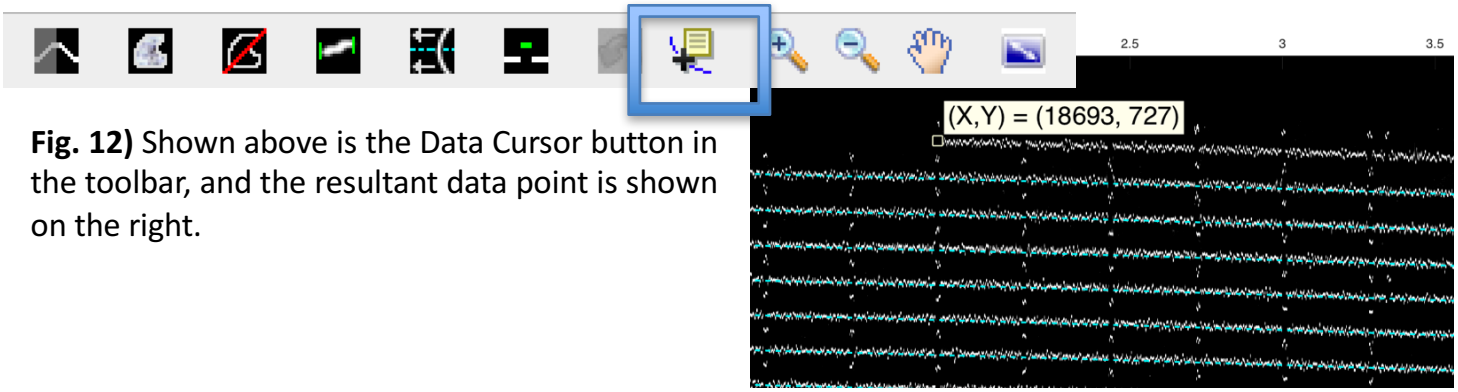


Fig. 12) Shown above is the Data Cursor button in the toolbar, and the resultant data point is shown on the right.

Classification

When the Edit Classification in the left sidebar button (located directly below the Adjust Traces button) is clicked for the first time, objects are classified as being a main trace, timemark, or noise object. Like the zero lines, these are not always correct. Therefore, the user must go through the seismogram and check to make sure that everything has been classified properly.

The Edit Classification button will also open a new window displaying the image. In this window, objects are colored either red, green, or white (Fig. 13). Red objects have been identified as “noise” and will not be included in the digitization, green objects have been identified as timemarks, and white objects have been identified as traces. The zoom and pan functions can be used as they would normally in the DigitSeis workspace.

The desired end-result of the Classification process is to have all the trace objects separated from all the timemark objects, and to have anything that is neither a trace nor a timemark classified as noise. This is crucial because DigitSeis considers timemarks and the trace objects separately in its calculations, that is, if a timemark is connected to or classified as a trace, its offset will not be corrected.

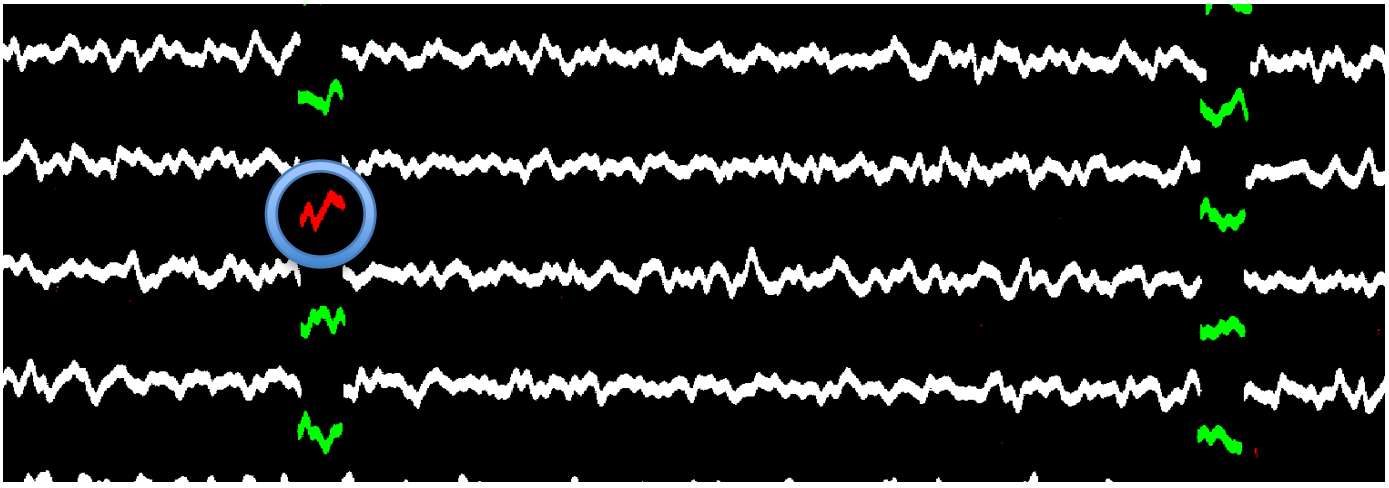


Fig. 13) Shown here is an example of what the user would see in the classification window. Note the traces in white and timemarks in green. Circled is one timemark object which has been incorrectly classified as a noise object and whose classification should be changed.

Classification

By using the Change Classification Buttons (Fig. 14), the user can reclassify any object to be noise, a timemark, or a trace. To use the Change Classification tool, the user should first select the button corresponding to the desired classification change (i.e. Red to classify as noise, Green/Blue to classify as timemark, and White to classify as trace) in the toolbar of the Classification window. After the button has been pressed, yellow crosshairs will appear on the image. Use the mouse to move these over to the object that needs to be reclassified and click. The object should change its color to the selected classification tool color. To get out of the reclassification tool, right-click (or press Enter) and the crosshairs will disappear.

Fig. 14) Change Classification buttons (box) and Remove Region and Remove Pixel buttons (circled)

Oftentimes, two separate objects are connected and need to be separated. This can be achieved using either the Remove Region or Remove Pixels tools (Fig. 14) depending upon the situation. To use the Remove Region tool, select the tool from the toolbar and click and drag to encircle the region which is to be removed. The Remove Pixels tool works in a similar fashion. The user should select the tool from the toolbar and then click and drag to create a line along which pixels will be removed. In the case that something has been removed in error, the Undo button in the toolbar can be used to recover the data. However, this feature only allows the user to undo the most recent action.

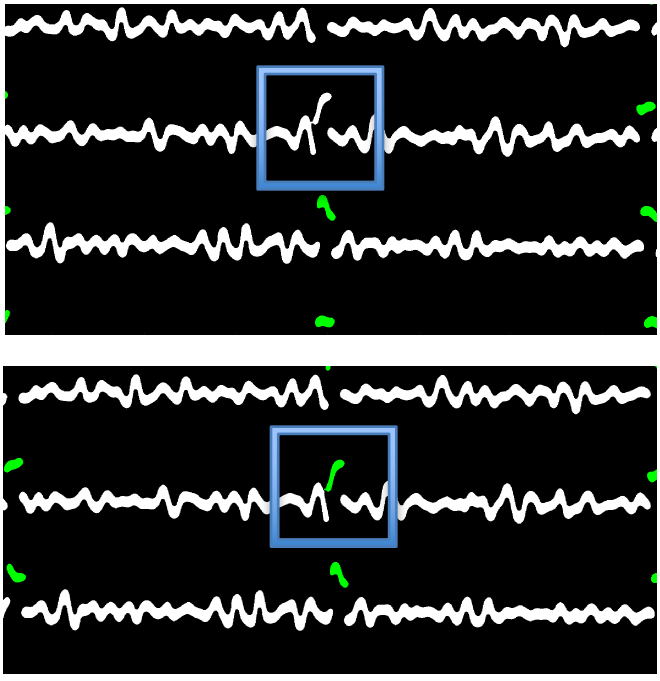
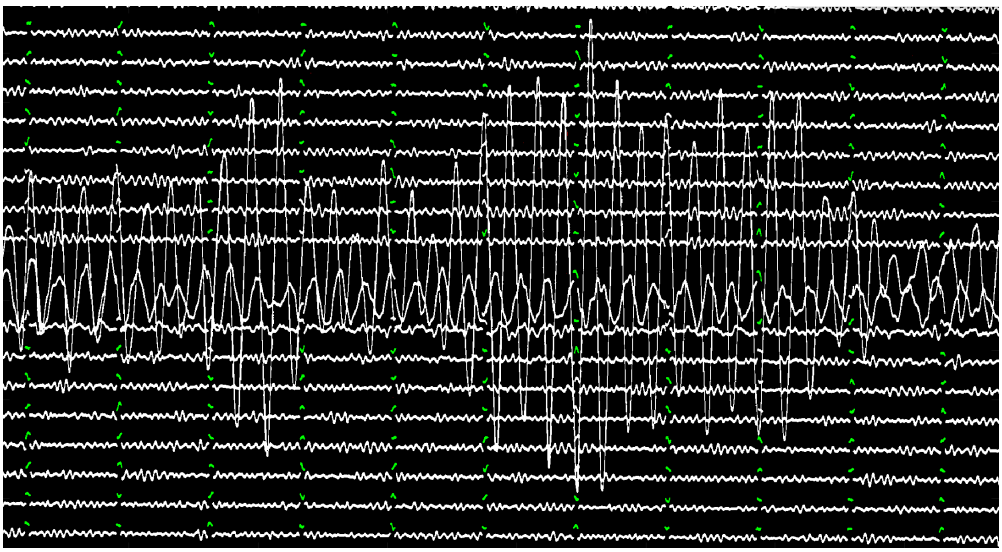
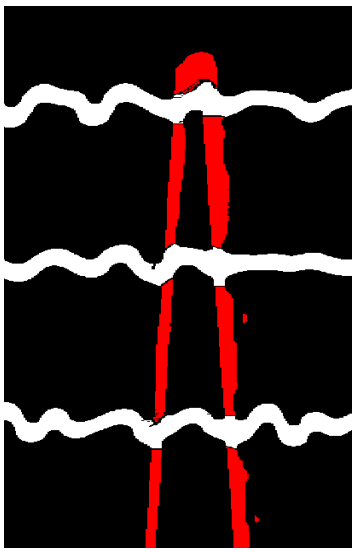


Fig. 15) In the image at Top Left, one can see a case where the timemark is attached to the trace object and as a result is also classified as a trace object (white). The image at Bottom Left represents the result of using the Remove Pixels function to separate the trace and the timemark. After pixels have been removed, the objects will be reclassified, this time the separated timemark is correctly classified as a timemark object. In some cases, even after using Remove Pixels or Remove Region, the objects will not be reclassified correctly. In these cases, the Change Classification buttons should be used.

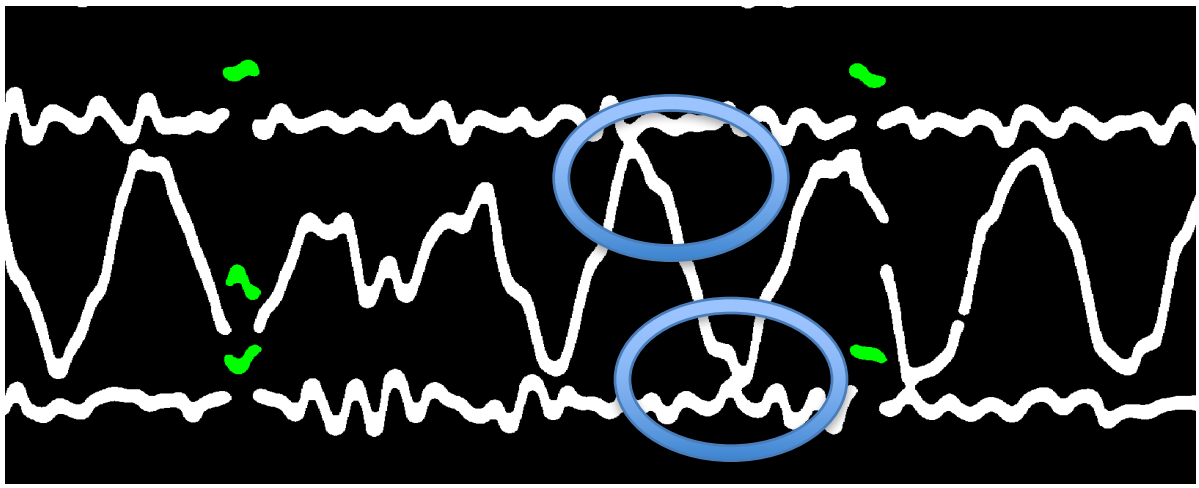
Classification

It should be noted that in the case where there are many crossed traces, it is often best to either separate out one trace or leave it all as noise. When this is done the Digitization algorithm will simply ignore the “noise” and the user can correct these traces during the trace correction portion of the process. (NOTE: objects classified as noise or removed in the classification window are not deleted, they simply are not considered during the automated digitization, and the data can be recovered during the correct trace process.)

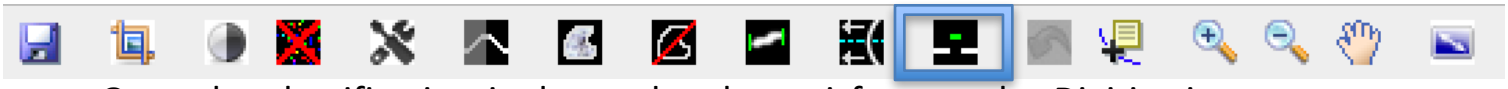




For example, in the above trace, the best option is probably to isolate the traces which are crossed and leave the crossing trace cut up and as noise (a close up example of this is shown Above Right). This way, during the Trace Correction process, the only trace which will need to be recalculated are the two crossing traces (as opposed to the dozen or so crossed traces). The user should always check the classification carefully for correctness. Some mistakes are hard to spot, for example, the case below with correctly classified timemarks, but connected traces that need to be separated.



Digitization



Once the classification is deemed to be satisfactory, the Digitization process can begin. If the timemark offset occurs downward (below the traces) it is necessary for the user to indicate this by selecting the Timemarks Down button (boxed above). To start the digitization process, simply click the Digitize button on the left side of the window and let the program run.

Once the digitization algorithm is running, a pie-chart will be displayed in the bottom right corner indicating the progress of the digitization (Fig. 16). Depending on the size of the image and the computer, this process can take anywhere from 5 minutes to over an hour with high-resolution HRV images. As traces are digitized, they will turn a shade of blue to represent the digitized traces and a shade of purple to represent the standard deviations. These layers can be toggled using the check boxes in the left sidebar underneath the Digitize button.

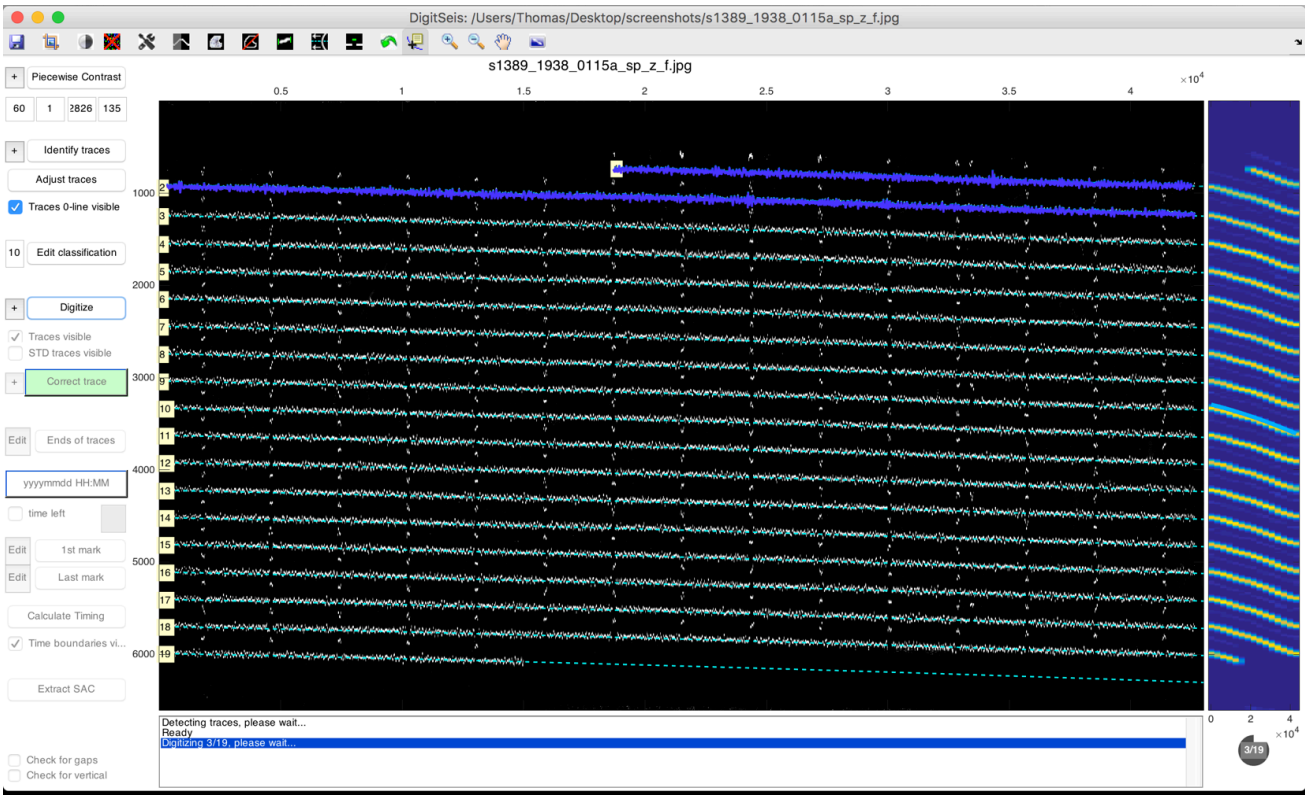


Fig. 16) As the automated digitization algorithm runs, a pie chart in the bottom right corner will display the number of traces that have been completed along with the number that are yet to be completed. Progress will also be displayed in the main window as traces change color.

Correcting Traces

After the automatic digitization process has completed, there are often inconsistencies in the traces which need to be corrected. For example, crossed traces, traces not digitized, or traces incorrectly digitized (Fig. 17).

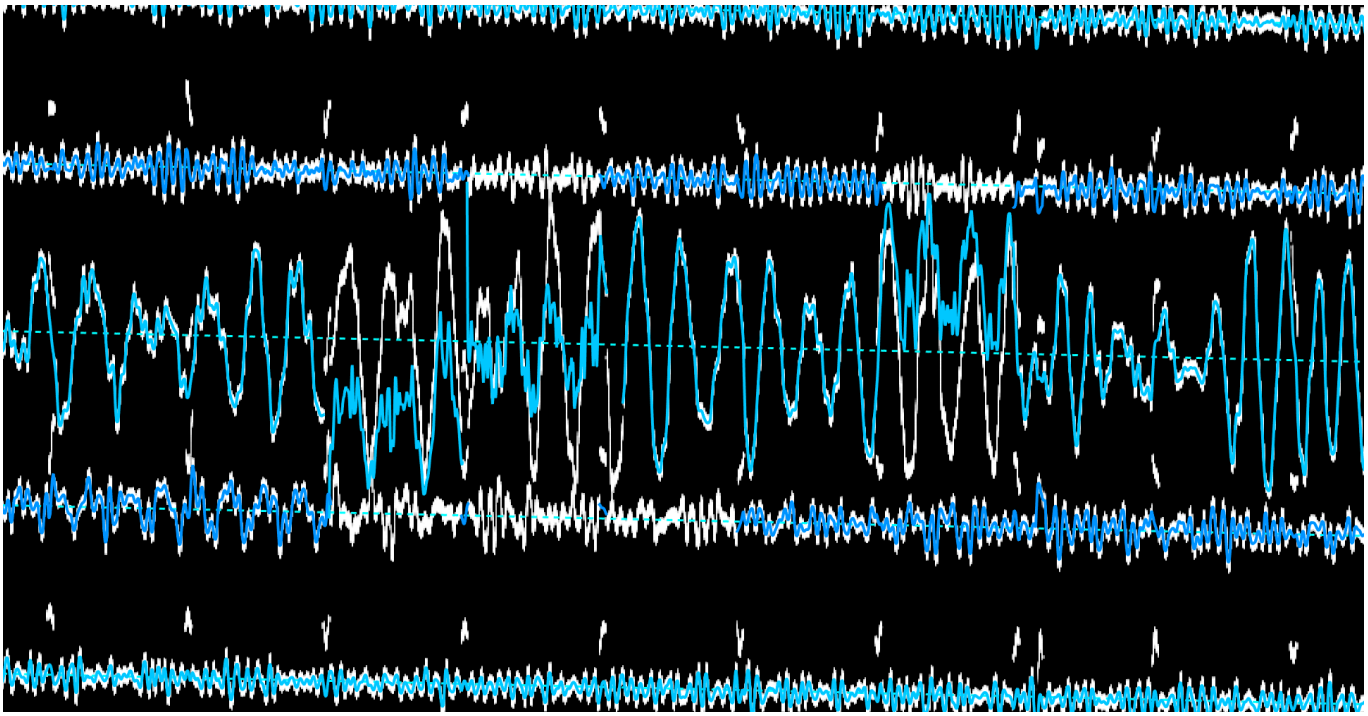


Fig. 17) In the above image, there are example of a seismogram where portions of traces have not been digitized, or have been digitized incorrectly. In this case, the issue has arisen from touching traces that were not separated during the classification stage. These problems can all be resolved by using the Correct Trace function.

These inconsistencies in the data must be corrected for the digitization to be accurate. This can be accomplished using the Correct Trace function. The Correct Trace function allows the user to go through the digitization, and redo small portions from the raw image. That is, the process of image processing and classification are redone, and a new digitization is calculated for this small portion. This is much more efficient than having to rework the entire image, and allows for a reasonable margin of user error or oversight when carrying out the classification step for the entire image.

Correcting Traces

To begin the correction process, the user should select the correct trace option from the left sidebar. A set of crosshairs will appear on the image. Use the mouse to move the crosshairs and click on the trace (close to the zero line) which you would like to edit. After this has been done, a box with draggable borders will appear. The user should use this box to select the area to be corrected, the borders can be finalized by double-clicking anywhere on the border (Fig. 18).

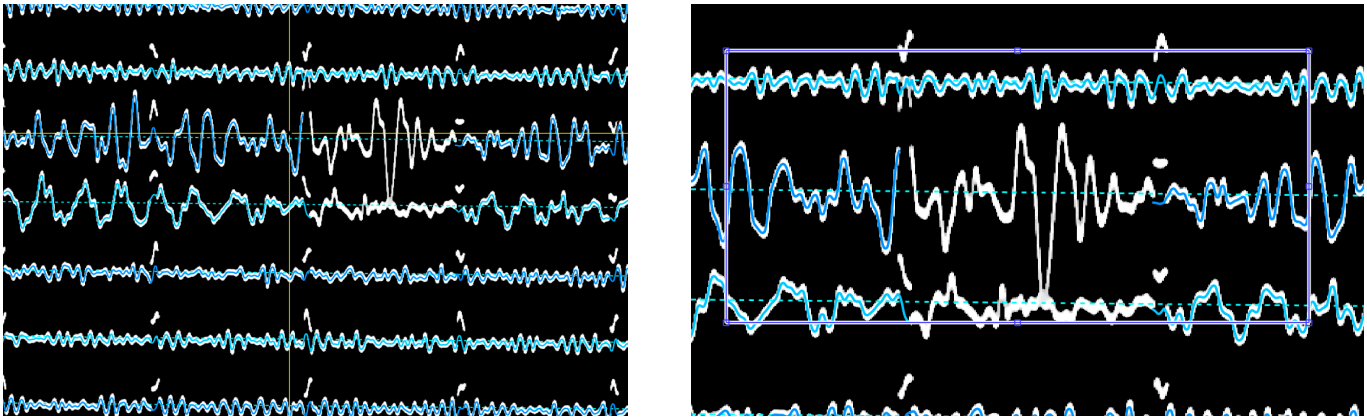


Fig. 18) The above images depict the crosshairs used to select the general region of correction (above left), and the box which is used to select the specific area of correction(above right). After the area has been finalized, the Correct Trace window will open (below).

Correcting Traces

In order to properly digitize the trace, the user should try to isolate only the trace in question (i.e., delete any crossing traces or parts of other traces that are in the working image). This should be accomplished by executing the following steps and tools (Fig. 19):

- In the Correct Trace function, the image that is displayed is the image showing only the parts of the trace that the classification step listed as being part of the trace in question. Other objects have been masked. The unmasked image can be seen by clicking on the Toggle Mask icon which allows the users to compare the original and masked images. Parts of the image that should not have been masked can be retrieved by the Region Retrieval tool. The tool works in a very similar way to the Region Removal tool. To retrieve a region from the unmasked image and have it show in the masked image, the user should simply select the Region Retrieval Tool and then click and drag to circle the areas that should be retrieved.
- Switch back to the masked image and use the Region Removal tool to trim out objects not belonging to the trace (e.g., other traces crossing through the trace of interest).
- Use the Calculate and Show Classification button to classify objects associated with this segment of the trace, and make any necessary corrections (See section on classification).
- Use the Digitize Trace button.
- Apply corrections back to the main trace using either the Apply Skip NaN button or the Apply Include NaN button, both located in the bottom left of the Correct Trace window.

See Fig. 20 on the following pages for an step-by-step illustration.

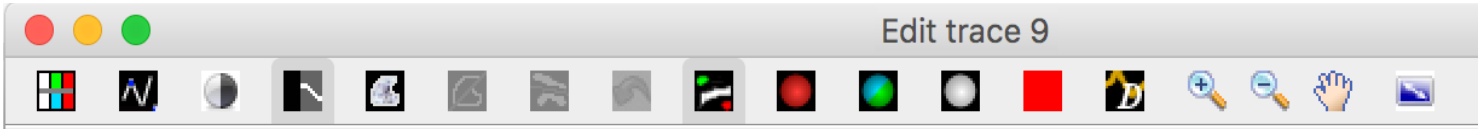


Fig. 19) (Above) The toolbar for the Correct Trace window, like that of the Edit Classification window, adds a few new tools. In this case, the important new additions are the Adjust Contrast (3rd from left), Toggle Mask (4th from left), Recover Region (5th from left), Calculate Classification (left of the change classification buttons), and Digitize (5th from right) buttons. For more information on toolbars, see Appendix A.

Correcting Traces

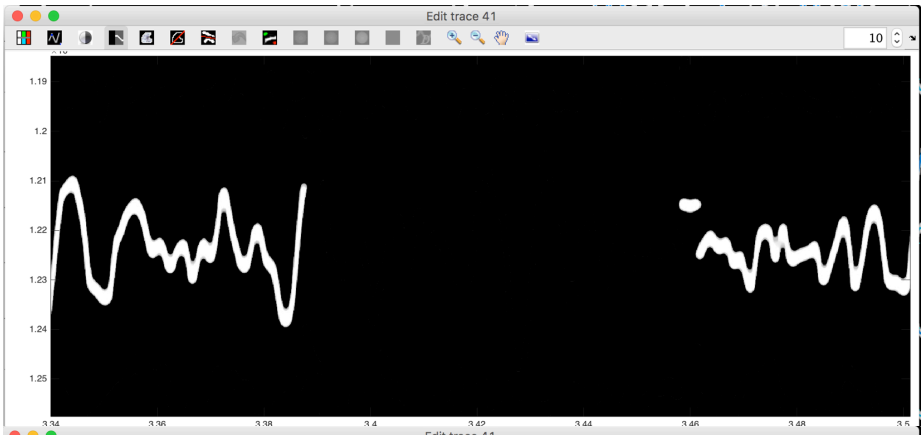


Fig. 20a) Some traces such as the one pictured here are digitized incorrectly because they are touched or crossed by other traces

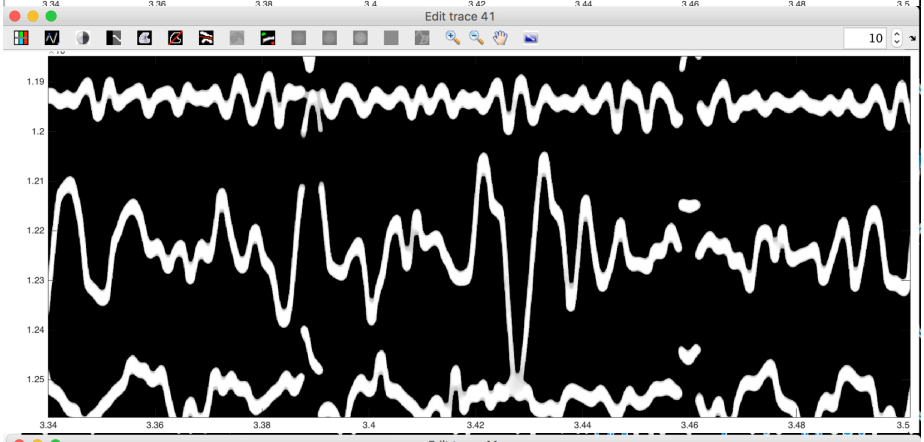


Fig. 20b) Here, the unmasked image is shown, note the presence of other traces along with the undigitized portion of the trace in question.

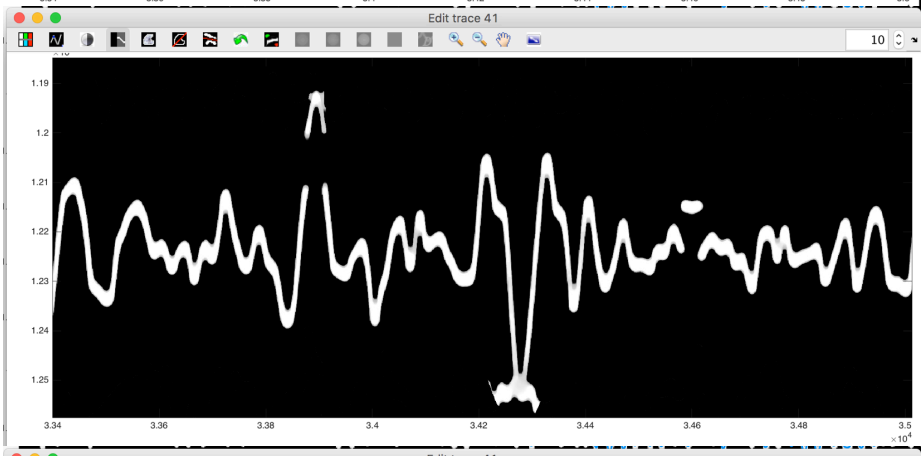


Fig. 20c) Here, the Region Retrieval tool has been used to recover the undigitized portion of the trace in question. Shown is the masked image after this has been done; compare this with the before in **Fig. 20a.**

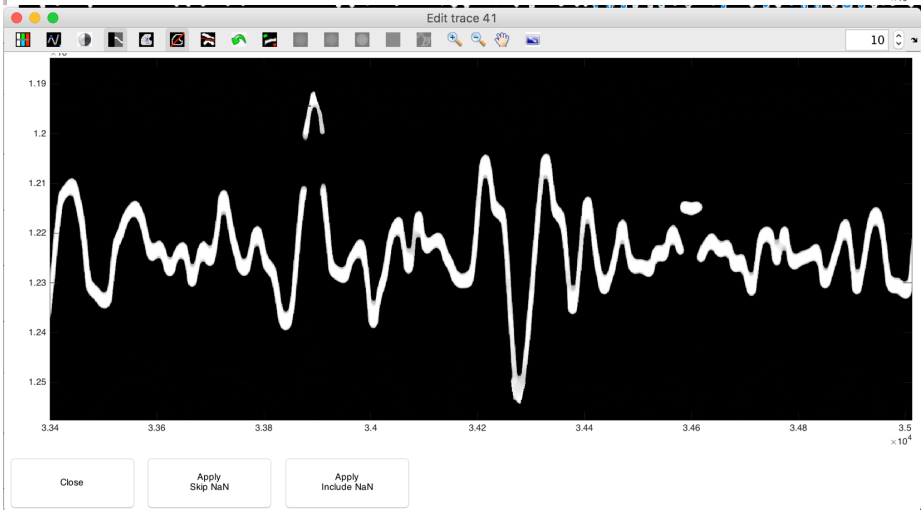


Fig. 20d) The main trace can now be isolated using the Remove Region tool to remove the crossing traces and isolate the trace of interest.

Correcting Traces

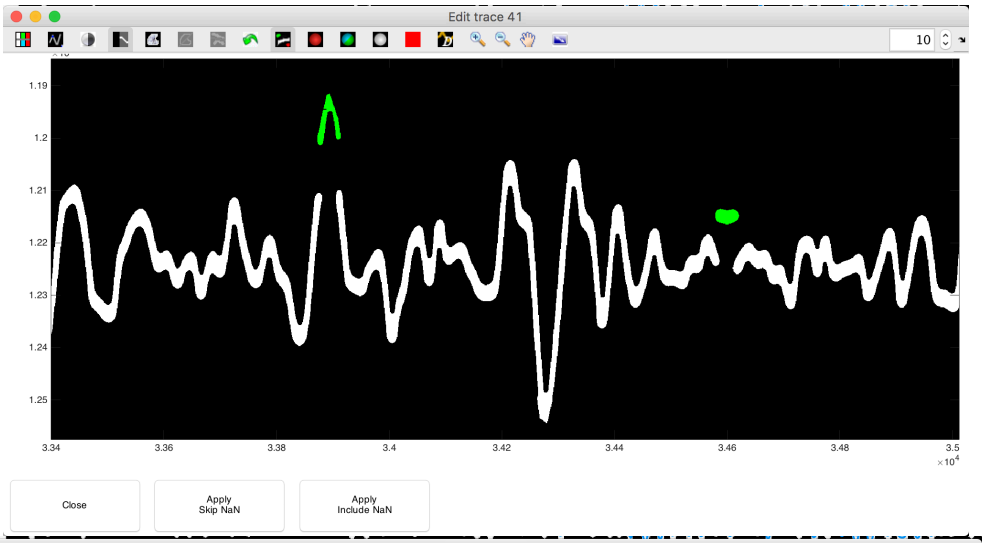


Fig. 20e) After the trace has been isolate, the trace must be reclassified. This process in almost exactly the same as in the Edit Classification window.

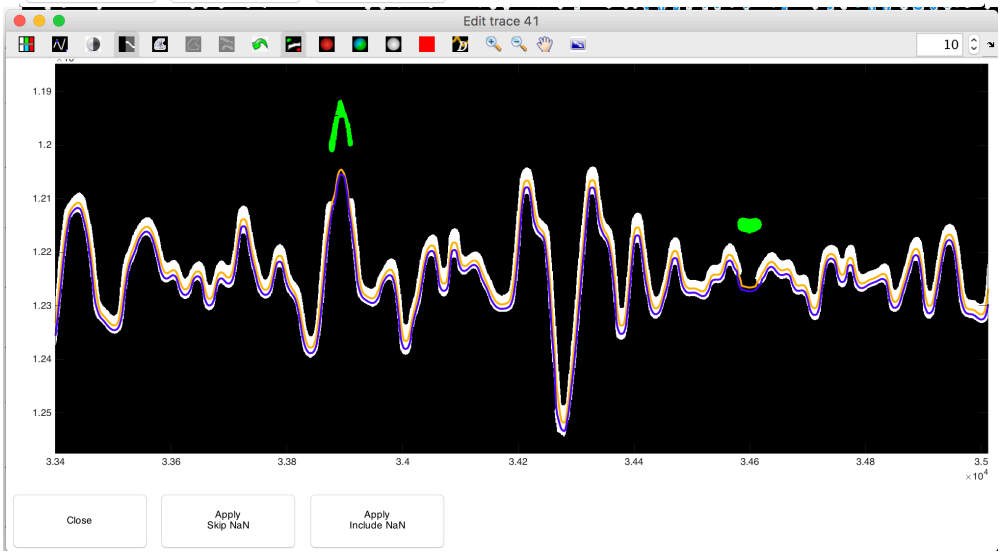


Fig. 20f) Once the trace and its associated objects have been properly classified, the user can select the Digitize Trace button to re-Digitize the portion displayed in the window.

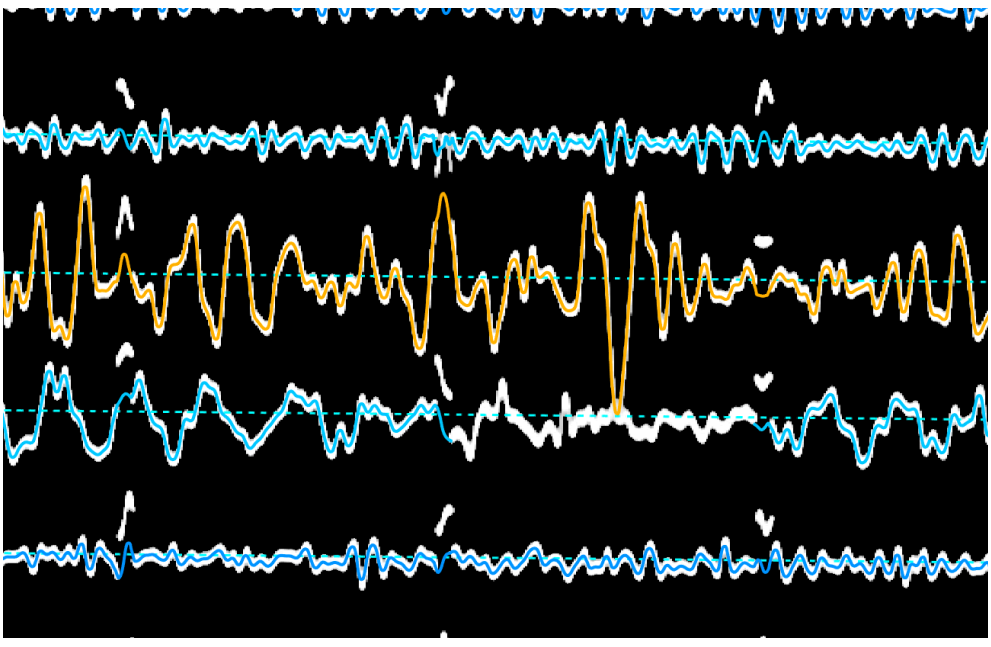


Fig. 20g) Once the above steps have been completed satisfactorily, the corrected trace can be reapplied back to the main trace using the Apply button.

Correcting Traces

When the correction process is finished, all traces should be completely and correctly digitized. Gaps in the digitized traces can be checked by using the Check for Gaps function. This function can be accessed by checking the Check for Gaps box located at the bottom of the left sidebar. This will show the seismogram with yellow boxes around locations that are not digitized (Fig. 21). The Check for Gaps function will show any point on the seismogram which does not have digitized data, however, please note that the Check for Gaps function will not find missing segment at the beginning or the end of the trace, and it will not identify areas where the trace has been incorrectly digitized.

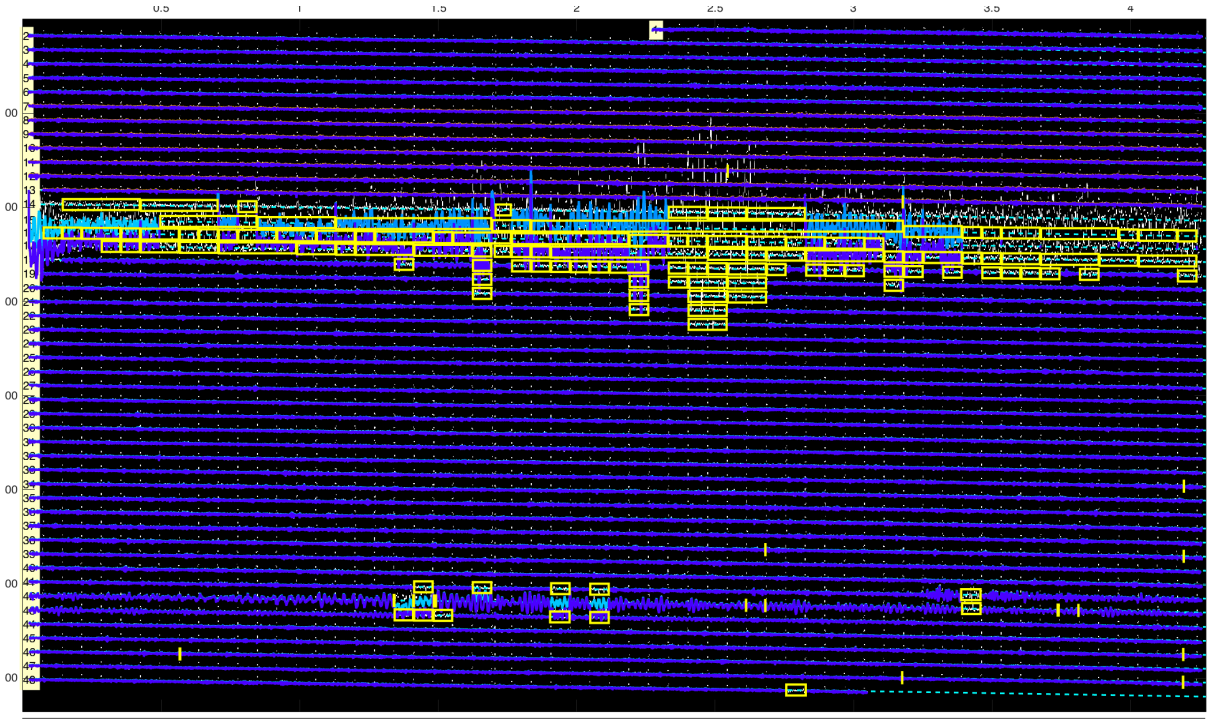
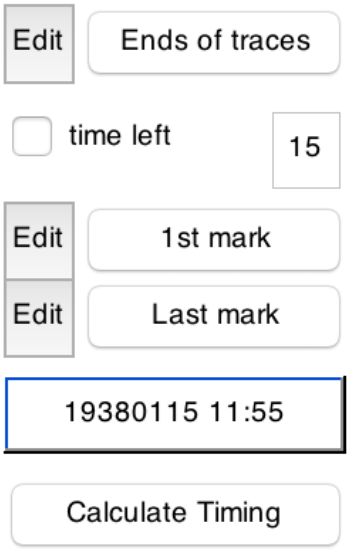


Fig. 21) Shown above is a seismogram with many crossed traces and missing portions. These are surrounded by yellow boxes when the Check for Gaps box is checked.

The correction process can also be accomplished using an alternative spline fitting method for situations where traces are extremely faint and objects cannot be recovered. For more details on this process, see Appendix B.

Timing

The next step in the process is for the software to associate each position with the specific time to which it corresponds. This timing process makes use of the timemark objects to interpolate the timing between timemarks (this is why it is imperative that the timemark objects be correctly classified and digitized). Before the Calculate Timing button can be pressed, the user must first identify the locations of the starting and ending points of the traces, the locations of the first and last timemarks , and the time (usually GMT) of the first time mark. During the process, the user will be using the below portion of the left sidebar.



The first step is to identify the ends of the traces. To do this, select the Ends of Traces button. An array of draggable dots (there should be as many dots as there are traces) will appear on the left of the image. Adjust the positions of these dots such that each dot is positioned at the beginning of the trace with which it corresponds. To finalize these positions, double click anywhere on the line. When this is done, a similar array will appear on the right. Mark the end points of the traces in the same way, and double click to finalize. This step can be redone by using the Edit button to the left of the Edit Traces button.

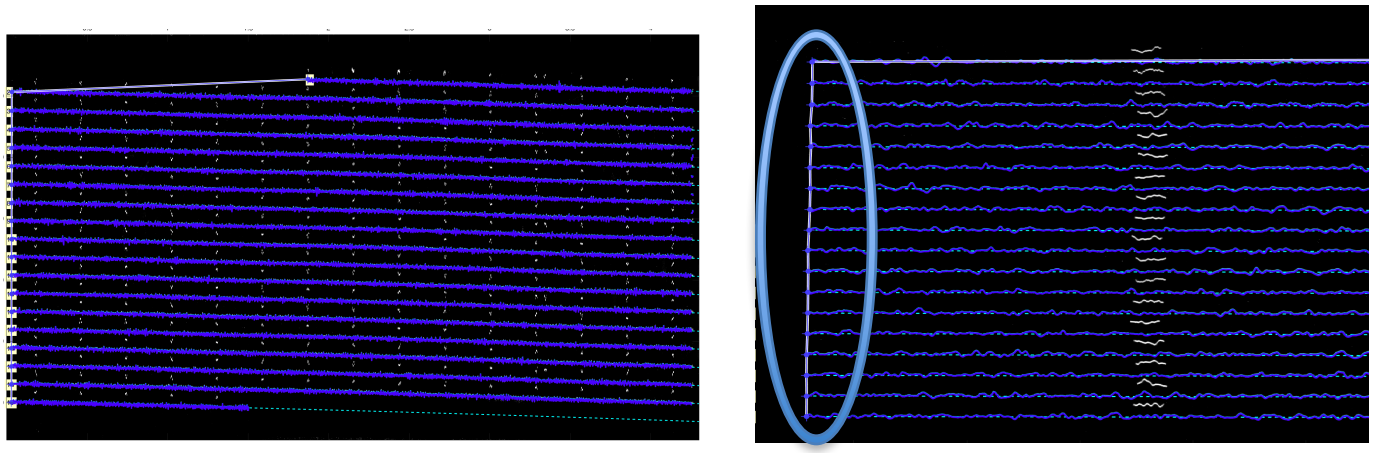


Fig. 22) Shown above is the array of startpoint markers, both in scope of the entire image (left), and in close up form (right). Note the one marker associated with trace one that is offset to the right to the same degree as is the beginning of the trace.

Timing

The next step is to mark the first and last sets of timemarks. This process is very similar to marking the beginnings and endings of traces. The user should first check the Time Left box if the measured minute begins at the beginning of the timemark, and if the measured minute begins at the end of the timemark, then the box should be left unchecked. Clicking the 1st Mark or Last Mark button will create an array of draggable dots where the software estimates the timemarks (either the first or last set dependent upon which option was chosen) to be. Again, these should be manually adjusted for accuracy if needed. In this process, only the timemarks that make a vertical line should be considered (e.g., offset time marks, such as those in the first and last traces, should not be included in the calculation). DigitSeis will only consider yellow dots, therefore, if the user desires for a dot to be ignored, the dot should be assigned a different color (Fig. 24). Once this has been done, the bottommost dot can be double-clicked to finalize the positions. Note that a full (or nearly full, aside from the top and bottommost traces) set of timemarks is desirable for accurate timing, and therefore it is sometimes necessary to use the second or second to last sets of timemarks.

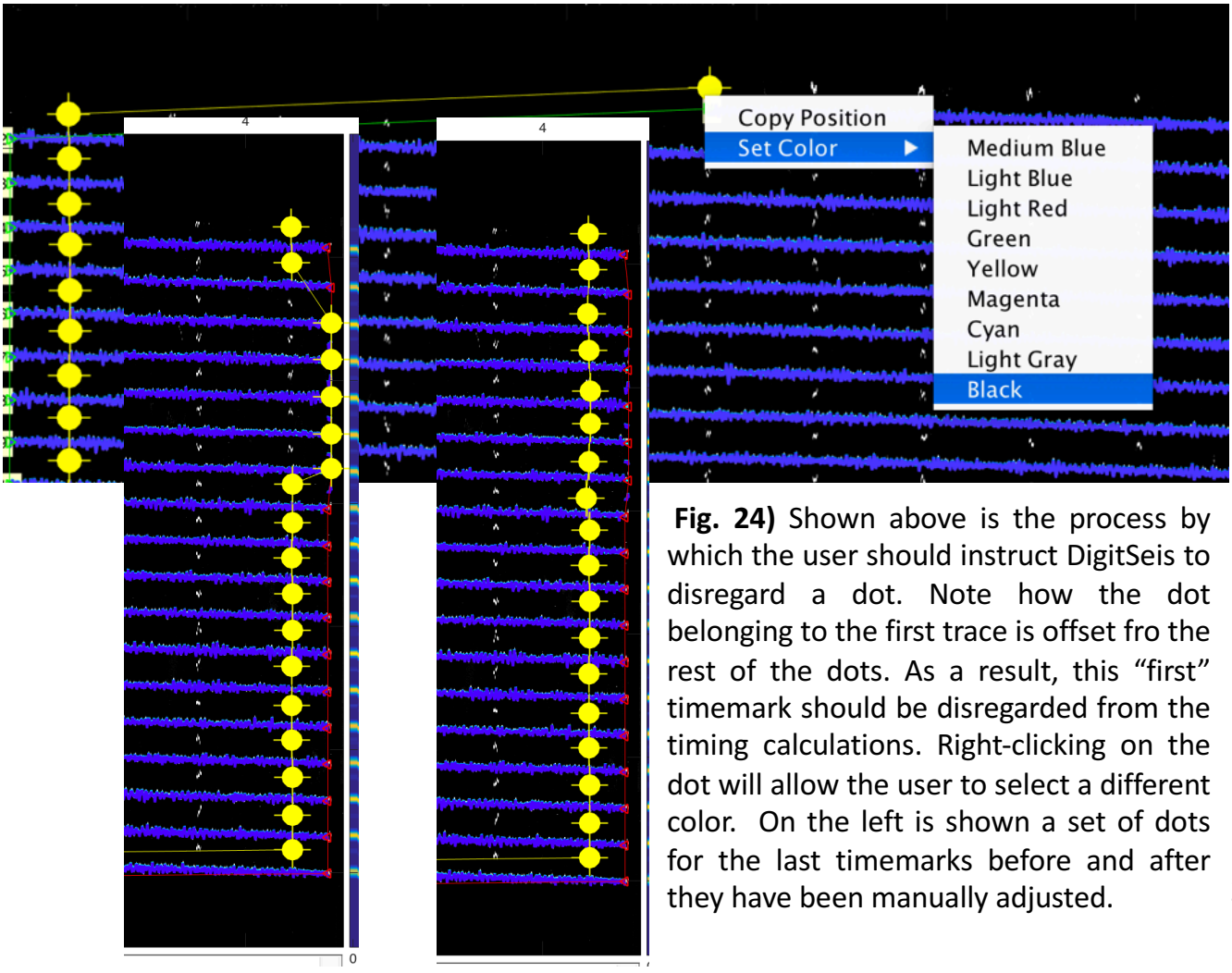


Fig. 24) Shown above is the process by which the user should instruct DigitSeis to disregard a dot. Note how the dot belonging to the first trace is offset fro the rest of the dots. As a result, this "first" timemark should be disregarded from the timing calculations. Right-clicking on the dot will allow the user to select a different color. On the left is shown a set of dots for the last timemarks before and after they have been manually adjusted.

Timing

The next step is to find the time corresponding to the first selected timemark (often not the one from the first trace). This can usually be determined by looking at the hour marks and counting the timemarks (usually one minute), though the notation will vary from seismogram to seismogram. These numbers should then be inputted by clicking on the box that initially has “YYYYMMDD HH:MM:SS” label, and filling in the requested data in the popup window.

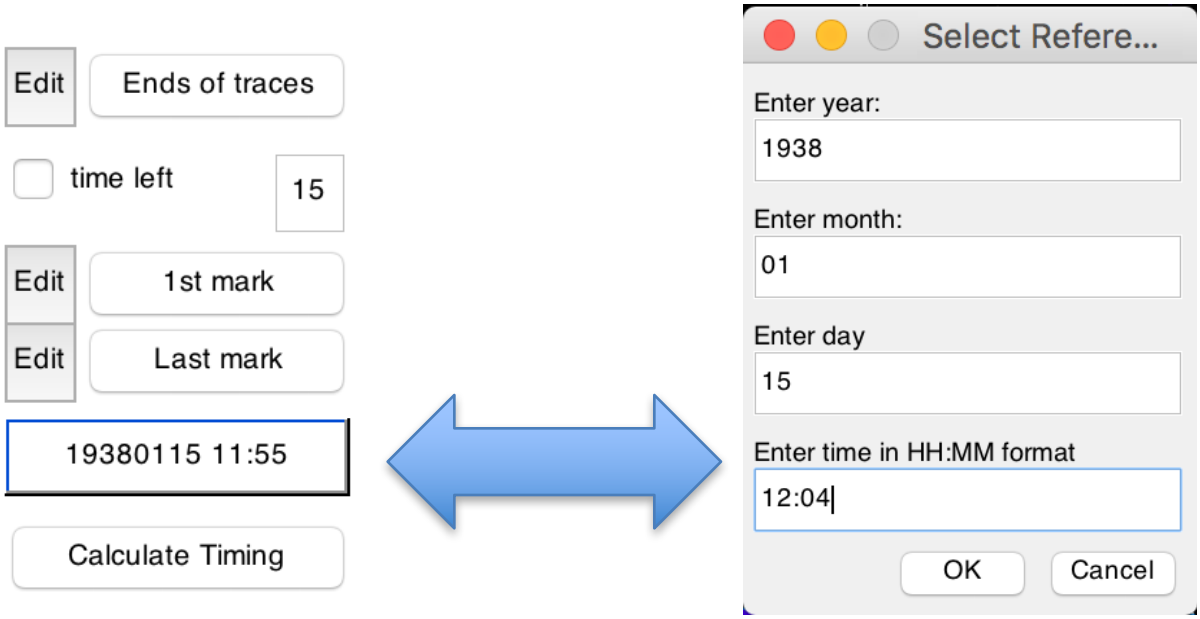
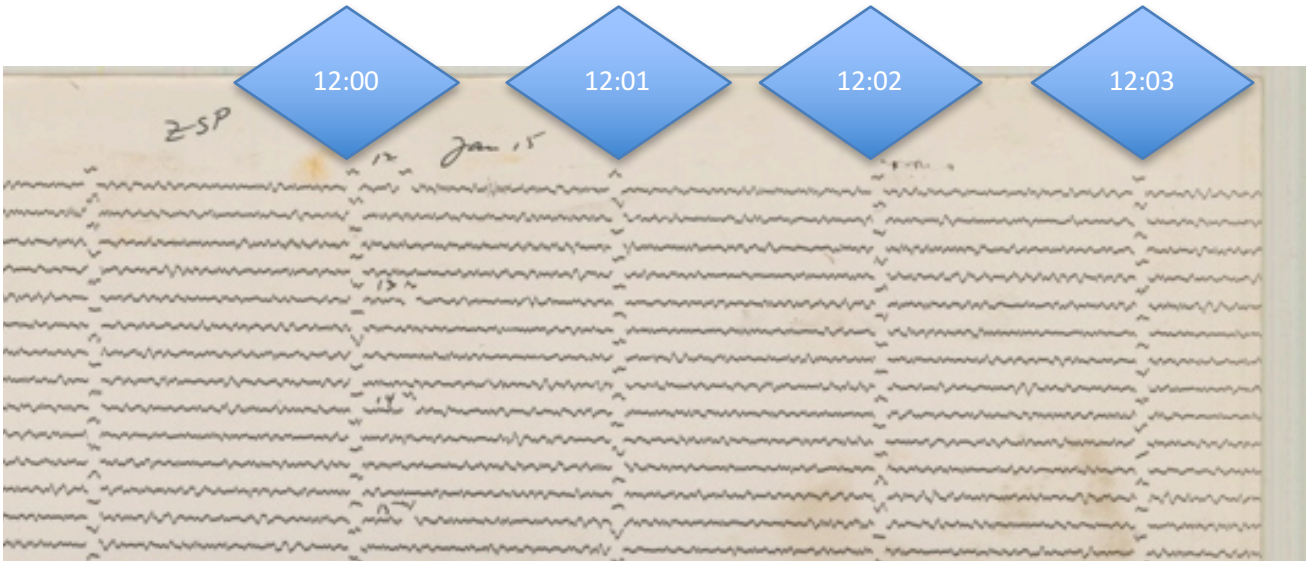


Fig. 23) Shown above is the Time Input box and its associated pop-up window. Below is an example of how one can count timemarks to determine the corresponding time of a specific timemark based on the hourmarks.



Timing

The last pieces of information necessary for the timing algorithm to run are the number of timemarks between the “first” and “last” set of timemarks. That is, the number of timemarks between the sets of timemarks which you used as the first and last set including the two (i.e., disregard any timemarks to the left of the “first” set or to the right of the “last” set). The number of time marks should be updated in the edit box right of “time left” checkbox. Once these steps have been completed, the Calculate Timing button can be pressed. When pressed, a progress bar will appear and the timing objects will populate (Fig. 25). The timing objects are: timemarks surrounded by a yellow box, and start points for each minute denoted by a yellow vertical line. The minute start points are draggable and should be adjusted as necessary. Note that the yellow boxes showing the timemark positions are not important, so even if a timemark appears in an incorrect location, this should be fine as long as the yellow vertical lines are at correct locations.

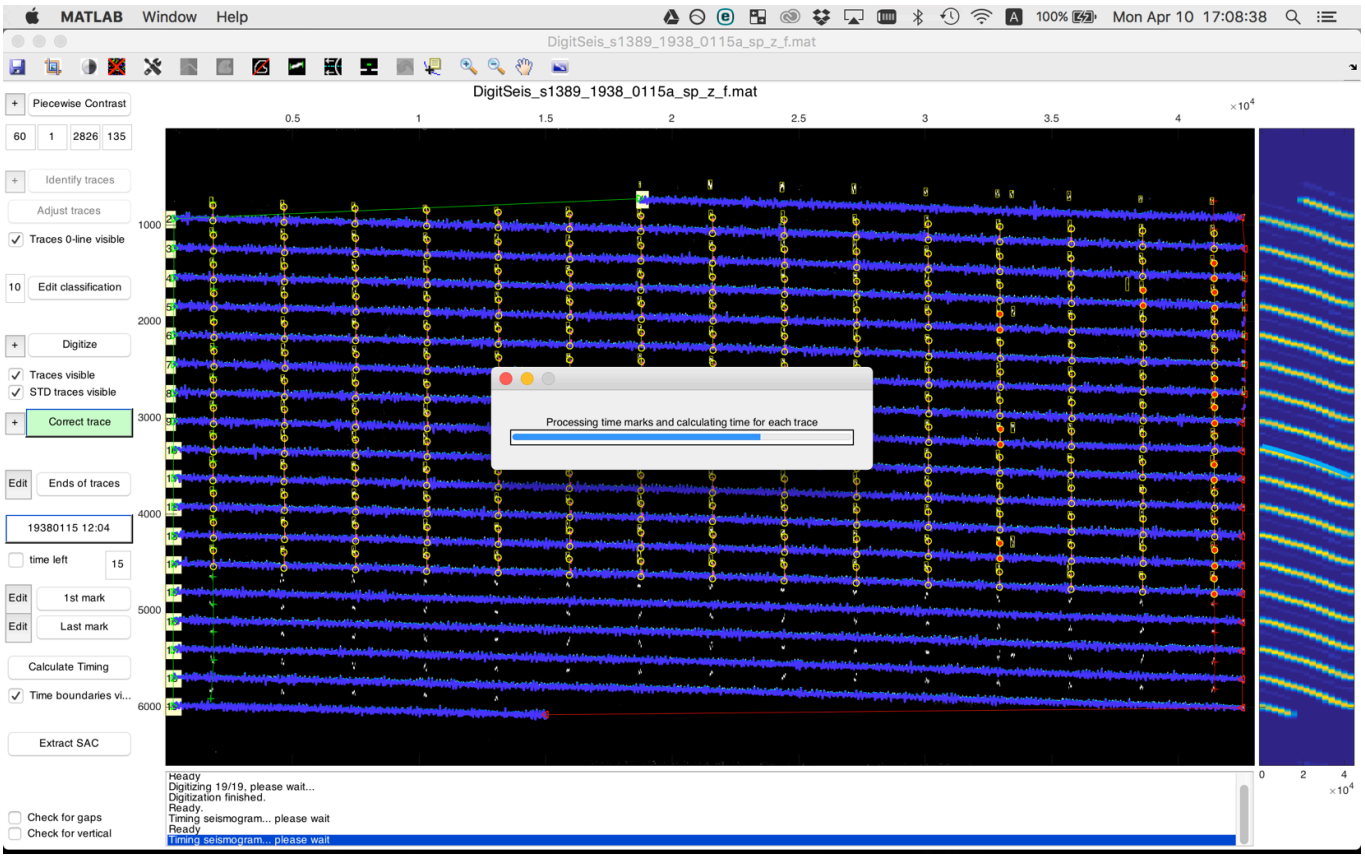


Fig. 25) Shown above is the Calculate Timing function as it runs. Note the progress bar, and the timing objects populating in the workspace behind the progress bar.

Extracting SAC

Final Analysis Save

Remember, in order to save an analysis in a .mat format, the Save button on the top left of the DigitSeis Toolbar should be used. Simply select the location for the save file, and hit ENTER (See Saving Analyses).

Saving as SAC

When the seismogram has been digitized, corrected, and timed, the user can save the data in SAC format. To save the data as SAC files, use the Extract SAC button on the bottom of the Left Sidebar. When this button is clicked, the Extract SAC window will appear (Fig. 18), and the user should input any known information in the boxes on the bottom. After this has been done, the user can select the option "Generate SAC files" on the bottom right and select the folder or location where these files will be created.

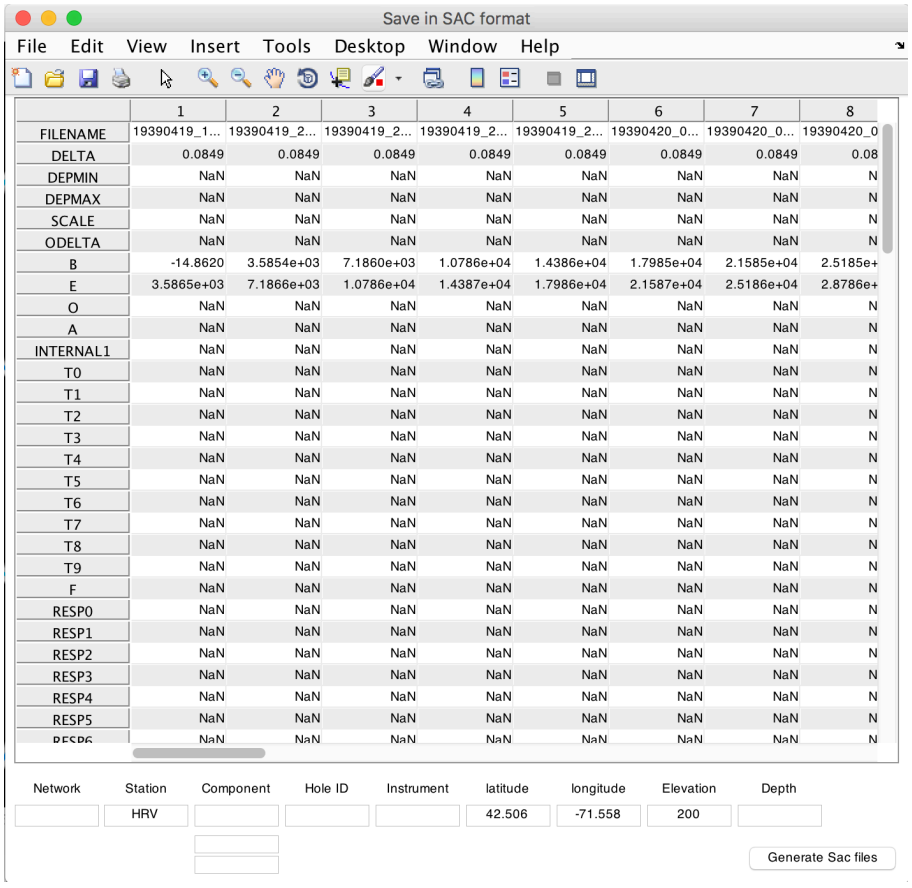


Fig. 18) The Extract SAC window. On the y-axis are the various header information to be stored within the SAC file. On the bottom, the user should input known quantities. For example, the user should be able to input the Network, Station, and Component by looking at information on the original seismogram. When done, the Generate SAC files button will create usable digital SAC data.

Appendix A: Toolbars

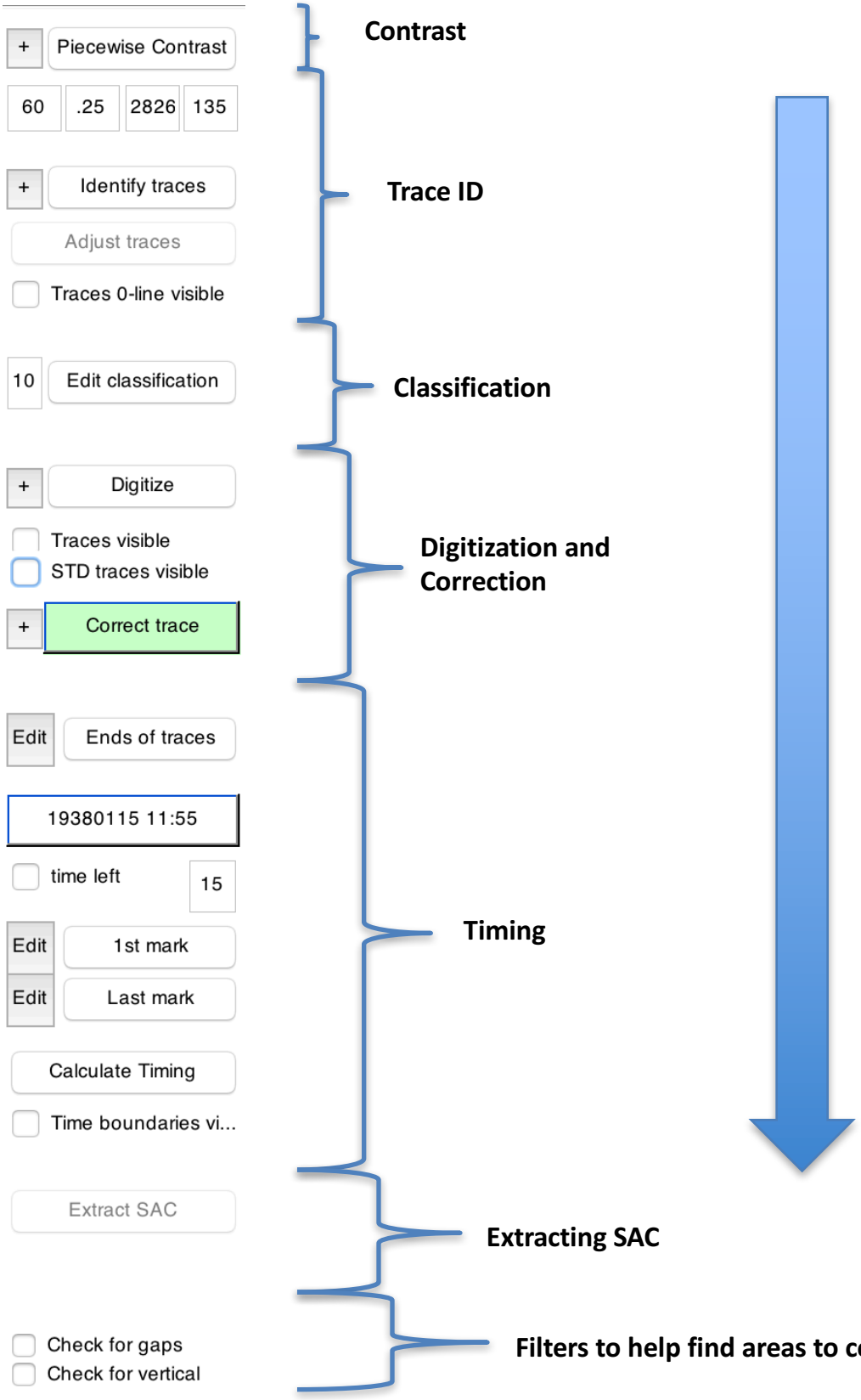
The DigitSeis Toolbar

From left to right:

- Save Files
- Crop Image
- Adjust Contrast
- Remove Salt and Pepper Noise
  - Can be used to remove spotting on the image (many small dots will be classified as noise and slow down the program)
- Edit Image
  - Can be used to access to select small region and process the region for better image quality.
- Toggle Original Image
  - Switch between the original image and the version where changes have been made.
- Recover Region
  - Recover regions from the original image and apply to the working image.
- Remove Region
  - Remove a region of the working image.
- Measure Tick Length
- Curvature
- Timemarks Position
  - Select this option to make sure that the position of the time mark (green segment) of the icon is consistent with the actual image.
- Undo
- Add Data Cursor
- Zoom In
- Zoom Out
- Move
- View Whole Image

Appendix A: Toolbars

The Left Sidebar



The Left Sidebar will populate with options which can be selected as the analysis is completed. That is, as the user works through the steps outlined in this manual, they will work from top to bottom with regard to this panel. This panel also includes many '+' buttons which allow for more control over the algorithms (See *Appendix B: Increased Controls)*

Appendix A: Toolbars

The Edit Classification Toolbar

From left to right:

- Colorblind Mode
  - Selecting this will make timemarks blue instead of green.
- Separate Traces
  - This function allows the user to draw a line along which pixels will be deleted
- Remove Region
  - Circle an area to be removed
- Undo
- Classify as Noise
- Classify as Timemark
- Classify as Trace
- Zoom In
- Zoom Out
- Move
- View Whole Seismogram

The Correct Trace Toolbar

All previously seen icons have the same function within the Correct Trace Window

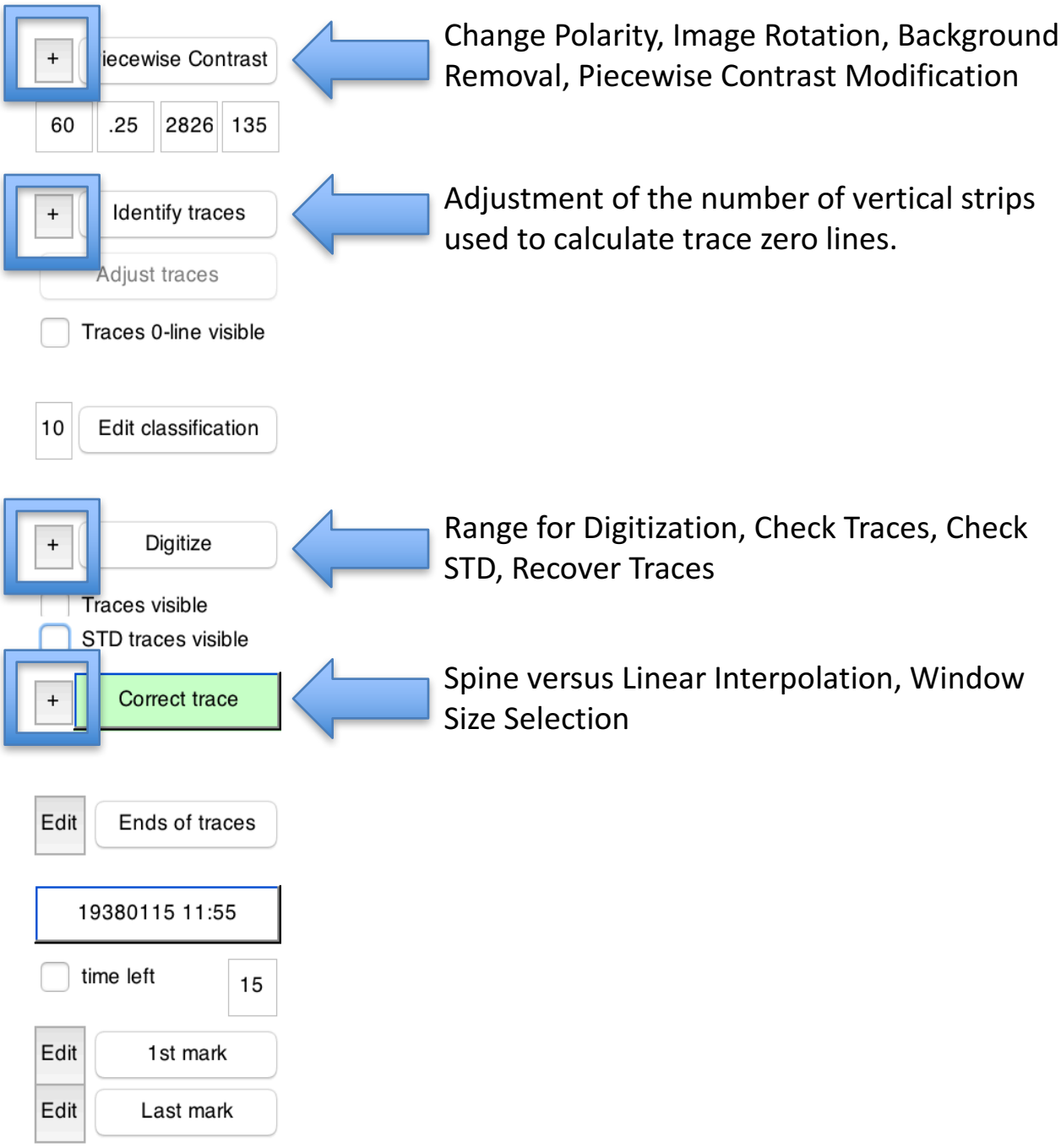
New Icons:

- Use Spline Tracing (See *Appendix B: Increased Controls*)
- Switch to Classification view (Fig. 20e)
- Recalculate Classification
  - If changes need to be made (i.e. regions are removed, the calculation should be reclassified upon reentering the Classification view)
- Digitize Trace (Fig. 20f)

Appendix B: Increased Controls

Using the + Button

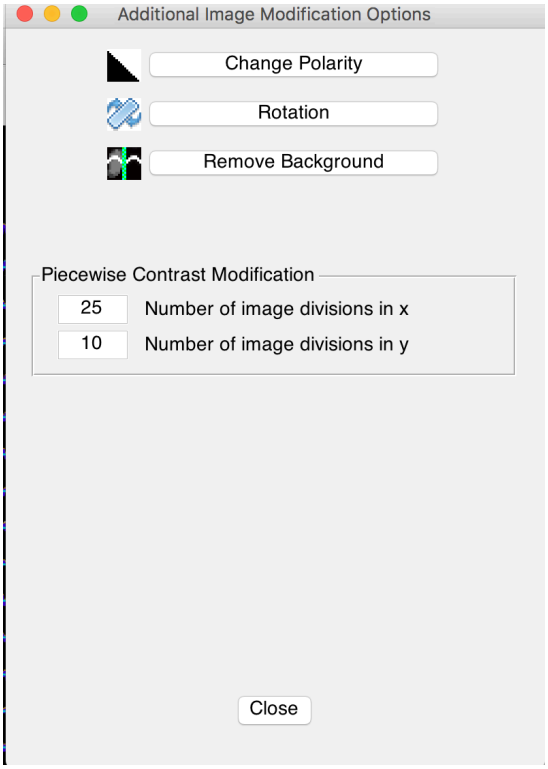
If more control over the software is desired, the user can utilize the + buttons for access to additional controls. Note that these features are additional controls and are not necessary to do a basic digitization. The + buttons are all located on the left sidebar. The different + buttons allows the user to access the following features:



Appendix B: Increased Controls

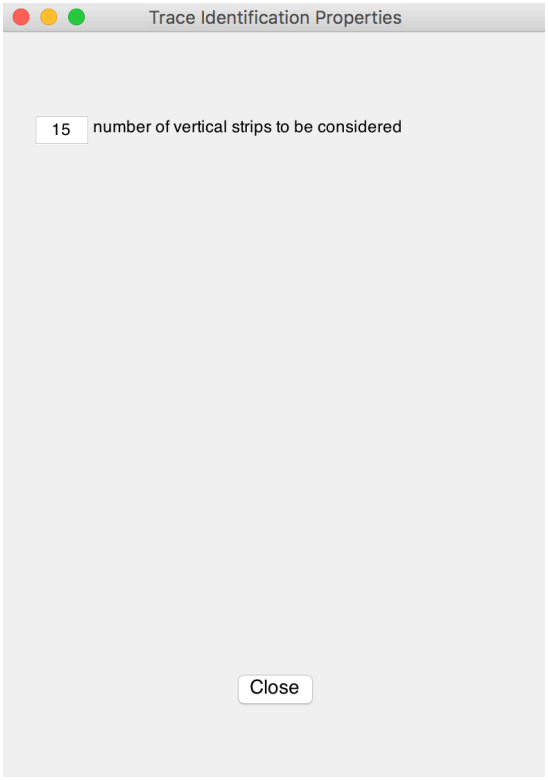
The Piecewise Contrast + Button

- Change Polarity: Flips polarity of the image
- Rotation: Rotate the image (if the traces are too far from horizontal, the Digitization will be incorrect)
- Remove Background: Allows the user to use Gaussian filtering to remove large blurs or stains on a seismogram
- Piecewise Contrast Modification: Allows the user to control the number of subdivisions in both the x and y directions

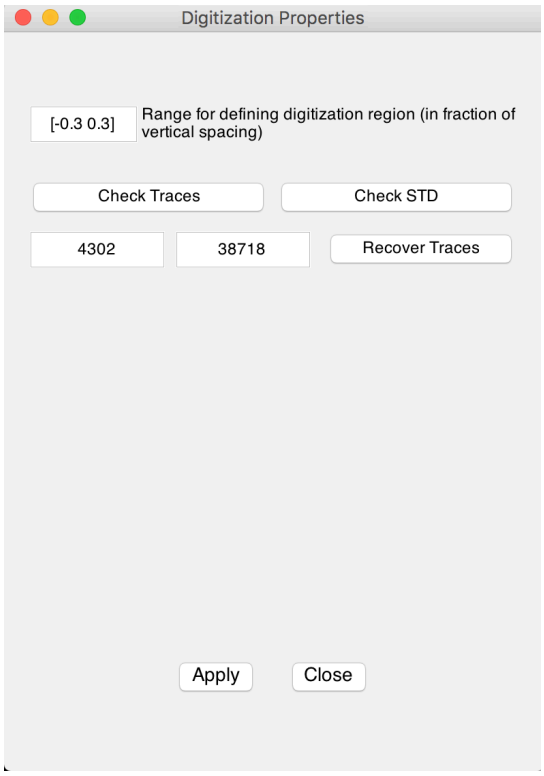


The Identify Traces + Button

- Selecting the '+' button here will allow the user to modify the number of vertical strips which the program will consider in the trace identification process.

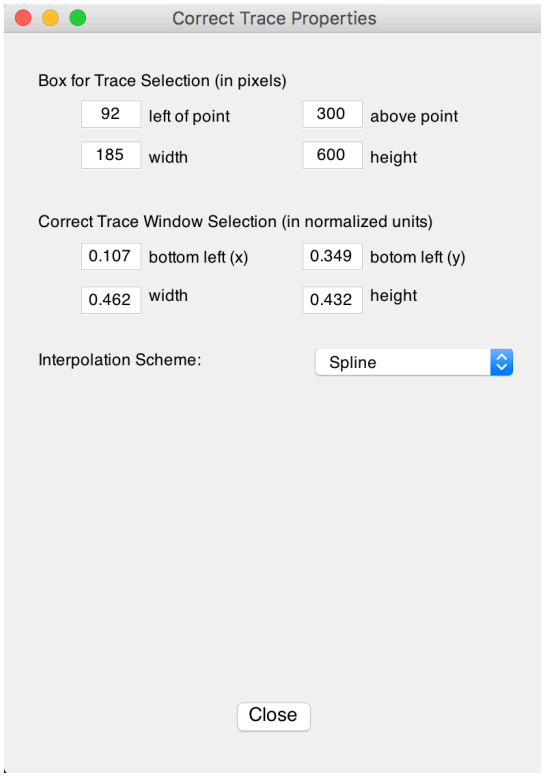


Appendix B: Increased Controls



The Digitize Traces + Button

- Range: This is the amount (in y direction) that the program will "look" at while assigning objects to specific traces
- Check Traces and Check STD: Cycles through the traces one by one and allows the user to check that traces and STD are in the correct order
- Recover Traces: When the above reveals problems, the user can specify the location of a trace and recover it



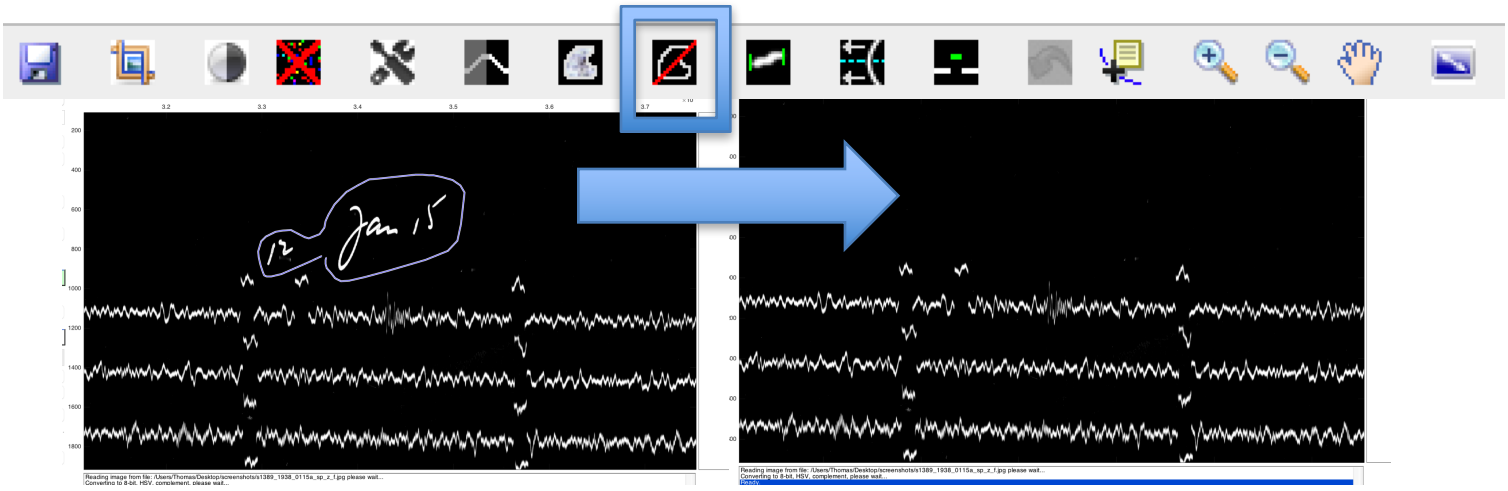
The Correct Trace + Button

- Selecting the '+' button here will allow the user to define the size of the trace selection box (in pixels) along with the location where the Correct Trace window will appear (in normalized units). The user can also switch between a spline or linear interpolation scheme here.

Appendix B: Increased Controls

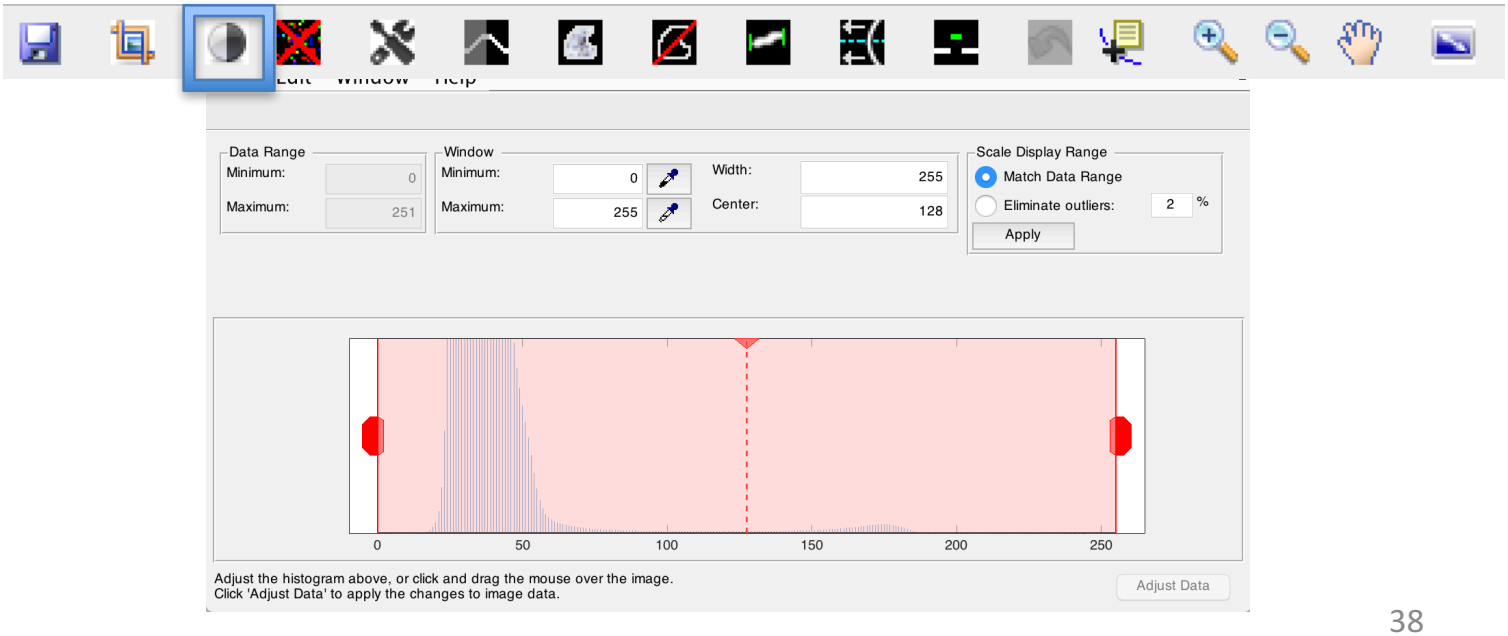
Region Removal

Sometimes seismograms have stains and notes written on them that can slow down the digitization process. These can be removed with the Remove Region tool (found on the main toolbar). To use the Remove Region tool, drag the mouse to circle the area which is to be removed (See Below).



Contrast

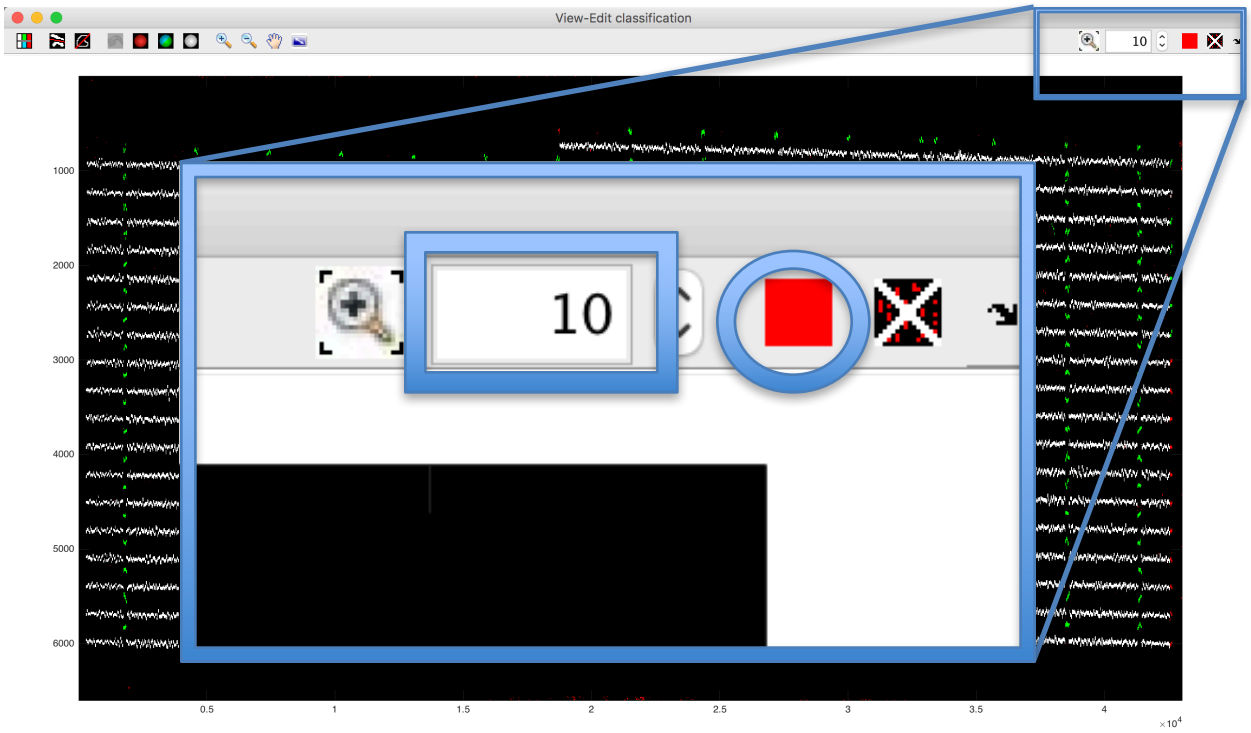
In some cases, the automated contrast adjustments calculated by the Piecewise Contrast function are not sufficient. If this is the case, the contrast of the image can be corrected interactively using the Adjust Contrast tool. Open the Adjust Contrast windows by clicking on the icon in the main toolbar, and dragging the upper and lower ranges in the Adjust Contrast pop-up window (Below). Use the Adjust Data button to apply this adjustment



Appendix B: Increased Controls

Luminance Threshold Number and Recalculating Classification

In the context of DigitSeis, the luminance threshold controls how bright or faint an object must be for the program to consider it to be an object in the classification. In some cases, the user may find it helpful to adjust the luminance. To modify the luminance threshold, the user can change the value in the box next to the Edit Classification button in the left sidebar, or can use the box in the top right of the Edit Classification window (boxed below). When using the box in the Edit Classification window, the user must recalculate the classification with the red Recalculate Classification button next to the luminance threshold box (circled below).



Changing Color Scheme

For some users, the red and green used to represent noise and timemarks, respectively, in the Classification stage can be hard to tell apart. In such cases, the Colorblind Mode button will change the timemark color to blue.

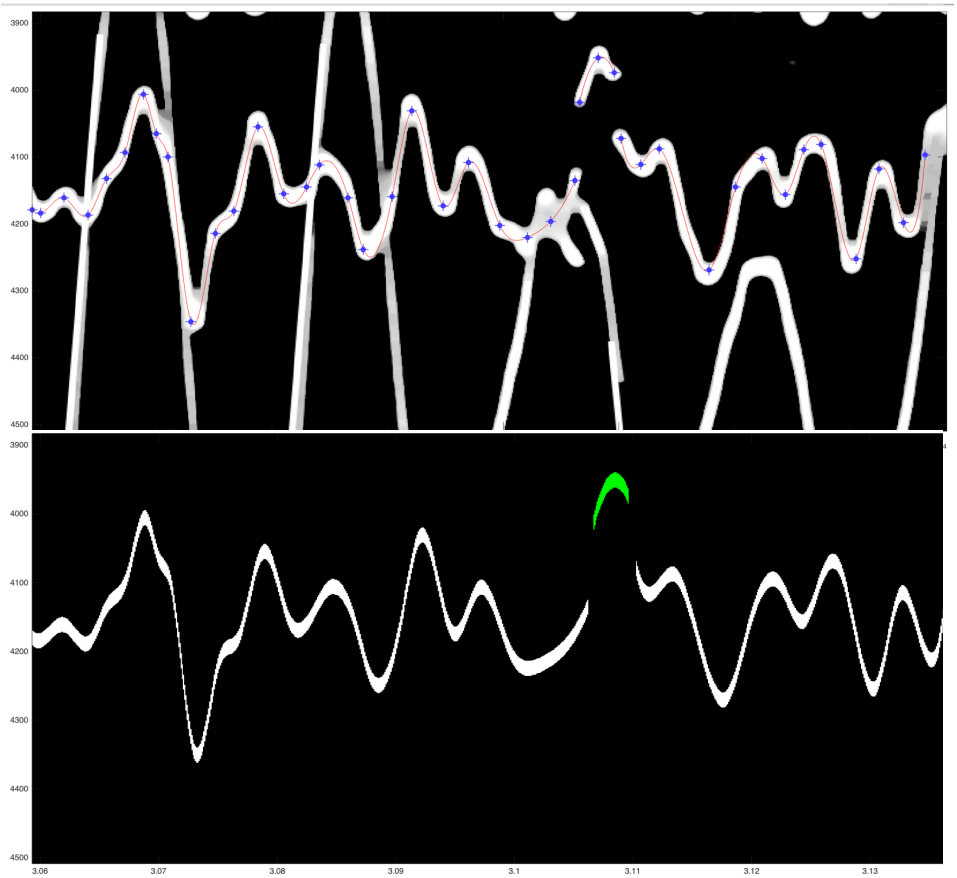
Appendix B: Increased Controls

Spline Fitting (alternative method for trace correction)

In some cases, the traces are indistinct and must be traced over using a manually fit spline (even when traces are distinct, this feature can be helpful in order to avoid removing a large number of crossed traces). To access this future, click on the Spline Tracing button in the Correct Trace toolbar (see Appendix A).

Follow these steps:

- Click on the Spline Tracing button and add points for one spline. When finished right click.
- Adjust the spline points to get a good fit
- Delete spline points by right clicking and selecting 'Delete'
- Add spline points by clicking in between the two endpoints of the already defined spline. (If you need to extend the spline, move an endpoint and click to add a new point between the endpoints)
- To add a new spline click the Spline Tracing button again. (Top)
- When you have fit your splines, click on the Switch to Classification View button, and continue the process as described in the Correct Trace section (Pg. 23 and 25) (Bottom)



Top Left: Correcting a trace using the Spline Fitting option. Note how it was not necessary to remove the crossed traces.

Bottom Left: The trace classification calculated by selecting the Switch to Classification view from the Spline Fitting