

SedCT v. 1.08 User Guide

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SedCT is a MATLAB based application for quick, user-friendly processing of sediment core CT data, collected on a medical CT scanner. Please contact Brendan Reilly (breilly@coas.oregonstate.edu) with feedback, questions, and issues.

Please cite:

Reilly, B., Stoner, J., Wiest, J., (in review) SedCT: MATLAB™ tools for standardized and quantitative processing of sediment core computed tomography (CT) data collected using a medical CT scanner.

Requirements:

- MATLAB version 2012 or more recent.
- MATLAB image processing toolbox.
- MATLAB Statistics toolbox to use the new 'Vertically Straighten' option (SedCT will work fine without this tool box, if you don't click that check box).
- CT data in DICOM format (Axial, coronal, or sagittal plane slices; see Figure 1)

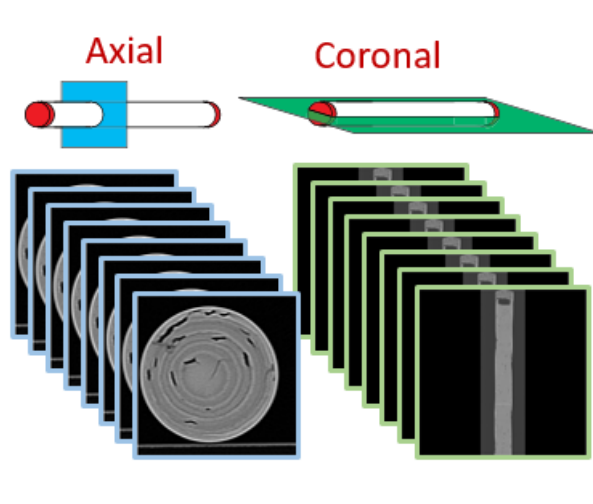


Figure 1. Examples of Axial and Coronal CT slices.

Getting Started:

- 1) Add the SedCT folder to your default MATLAB directory. On a windows computer, this is generally .../Documents/MATLAB. The folder should contain the following files:

```
SedCT.fig  
SedCT.m  
SedCTimage.fig  
SedCTimage.m  
Blank_screen1.tif
```

- 2) Create a MATLAB script named 'startup.m' (or open, if already in existence).
- 3) Copy and paste the following into 'startup.m' and save.

```
addpath('SedCT');
```

- 4) Next time you open MATLAB, the SedCT directory path will be added automatically.

Preparing your data:

- 1) SedCT works best when a single core is scanned and then the data are organized in a data structure format consistent with the OSU standard prior to 2021, with the DICOM files of the top interval of each core section in one directory and the DICOM files of the bottom interval of each core section in another directory.
- 2) For some data collected in 2021 or more recently, the top and bottom intervals of a core section may be in the same directory and will likely cause an error or lead to other problems. You may need to split the files into two separate directories. At this point, this can be done manually or by using **SedCTsplit** (included in version 1.08). We are working on a better solution and if you have any questions, feel free to contact Brendan.
- 3) For multiple cores scanned together, including u-channel samples scanned using the OSU tray, you will need to break them apart into separate DICOM files. This can be done using **SedCTsplit**. A workflow for **SedCTsplit** is included with version 1.08 zip directory.

Opening SedCT:

- 1) Open MATLAB and type **SedCT** in the command line and hit enter. The SedCT graphical user interface (GUI) will open in a new window.
- 2) Orient yourself the GUI. On the left are input (Figure 2a) and processing parameters (Figure 2b). The center is the data viewer (Figure 2c). On the right are tools to manage cores run in multiple intervals (Figure 2d) and to export the results (Figure 2e). There are slight changes to the user interface for v. 1.08 that are not pictures in Figure 2.

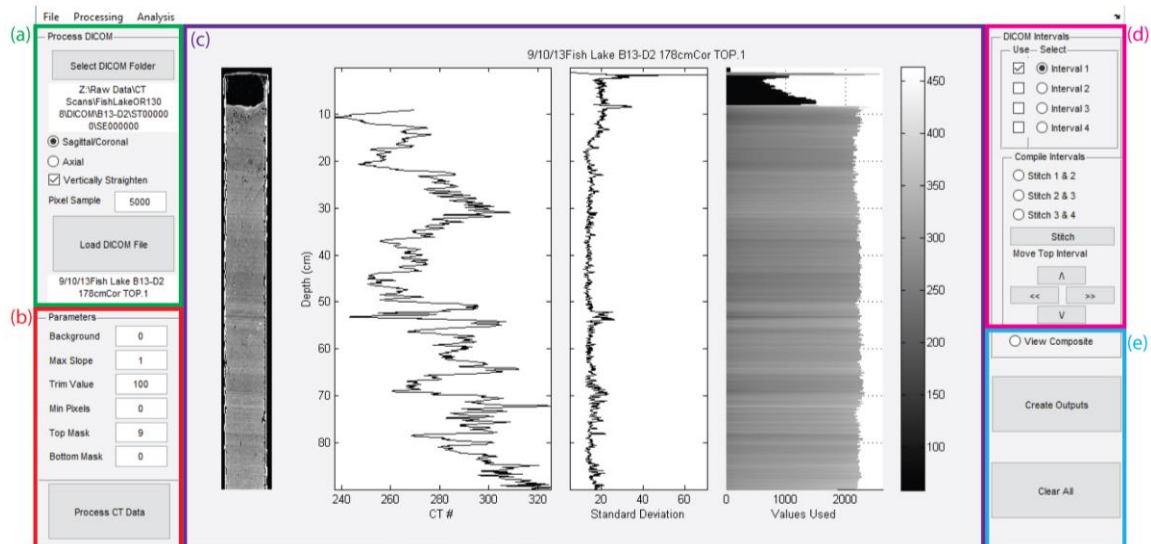


Figure 2. The SedCT v1.01 graphical user interface (GUI).

Import Data:

- 1) Often sediment cores are scanned in multiple intervals. If possible, these should have slight overlap. SedCT can work with cores run in up to 4 intervals, although generally you will just have two (a top and a bottom interval for a standard 1.5 m core section). Select the intervals you would like to import at the top right of the screen by clicking the round radiobutton (Figure 2d). **Interval 1** should be the top of the core.
- 2) Click **Select DICOM Folder** and select the folder containing your DICOM files (Figure 2a).
- 3) Select the plane your DICOM files are processed in by clicking the **Sagittal/Coronal** (default) or **Axial** round radio button (see Figure 1).
- 4) Sometimes cores are run at a slight angle. Check the **Vertically Straighten** check box if you would like SedCT to correct for cores run at a slight angle. Note, this option requires the Statistics Toolbox.
- 5) Choose the number of random unique pixels you would like to sample in the first box, **Pixel Sample**, under the **Parameters** heading (default: 5000 pixels). If you select a value larger than the number of pixels at each horizon, all pixels will be used. Decreasing the number of pixels will allow for faster processing.
- 6) Click **Load DICOM File**. SedCT will load in each DICOM file.
- 7) After loading the data, SedCT will display a black and white cross section image of the core. A red line (by default at halfway down the CT volume (value = 50 %)) will indicate which slice will be used for the slice image. If that level looks good, proceed to the next step. If you would like to change the slice used for the slice image, change the **Image Location (%)** value to reflect the horizon you want and click **Load DICOM File** again.

Process Data:

- 1) SedCT will process the data to isolate a distribution of CT values around a mode that is representative of the sediment itself. It may take some trial and error to find the optimal settings for your sediment, depending on factors like coring deformation and sediment structure.
- 2) Click **Process CT Data** to process the imported data (Figure 2b). Plots of the results will appear in the data viewer (Figure 2c). Parameters **Max Slope**, **Trim Value**, **Min Pixels**, **Top Mask**, **Bottom Mask** can be adjusted from their default values to isolate the most representative sediment CT value.

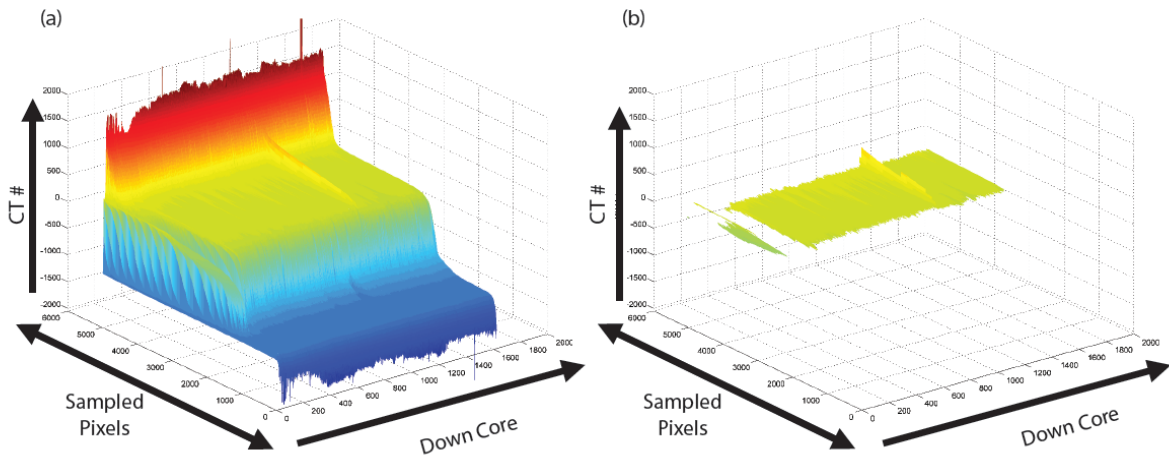


Figure 3. (a) Example of CT values extracted from a whole round sediment core and sorted from highest to lowest, with high values (red) representative of the core liner and low values (blues) representative of cracks, voids, and air. (b) Setting SedCT parameters, Background, Max Slope, Trim Value, Min Pixels, Top Mask, and Bottom Mask allow the user to isolate the CT values representative of the sediment itself (within the yellow range), from which a mean value can be calculated.

- a. **Background** (default: 0): This parameter sets the background CT Value that the user knows is not sediment. The default is 0, which, in HU units, is the value for water.
 - b. **Max Slope** (default: 1): This parameter determines the threshold for the range of values in the distribution around the representative mode (e.g. the maximum slope allowed in the distribution, as plotted in Figure 3). The user should choose the lowest value that yields a representative distribution. Higher values are useful in some cases, such as when there is significant coring deformation or where sediments are laterally heterogeneous, but can introduce a ‘smoothing’-like effect. It is best if this value is consistent between cores from the same core suite. Often, the user will notice that this value needs to be increased if SedCT is using a low or variable amount of pixels (alternatively, the user could try decreasing the Trim Value, below).
 - c. **Trim Value** (default: 500): This parameter defines the number of pixels to ignore from the edges of the isolated distribution.
 - d. **Min Pixels** (default: 0): This parameter determines the minimum number of isolated pixels determined to be reliable. If the number isolated, is less than this threshold, SedCT will return ‘Not a Number’ (NaN).
 - e. **Top Mask** (default: 0): This allows the user to mask CT values from the top of the core, in centimeters, that are not representative of sediment. This is useful for removing end caps, foam, or fall-in.
 - f. **Bottom Mask** (default: 0): Like **Top Mask**, but for the bottom of the core.
- 3) Repeat processing by changing parameters and clicking **Process CT Data** until desired results are achieved. The default settings for **Max Slope** and **Trim Value** are 1 and 500 respectively. If you are working with a small volume sample (e.g., a u-channel), you might need to reduce the trim value to as low as 25 or even 0. For larger samples, if you are not isolating enough values to get a good result, try changing **Max Slope** to 3-5 and reducing **Trim Value** to 100-300.

- 4) If core is run in multiple intervals, click the next interval's radio button at top right corner of screen (Figure 2d; Data viewer will reset to default) and repeat **Import Data** and **Process Data**. Do this until all intervals are imported.

Stitch the core intervals together:

- 1) Click check boxes at top right for each interval you will be using (Figure 2d). If only using one interval, just click the check box next to **Interval 1**, click **View Composite**, and skip to **Create Outputs**.
- 2) To stitch together two intervals, click the radio button under the **Compile Intervals** header (i.e. **Stitch 1 & 2** for intervals 1 and 2; Figure 4).
- 3) Click **Stitch**. Best guess results will display.
- 4) Refine the guess, first by moving the top interval up and down and then left and right using the arrow buttons under **Move Top Interval**. In version 1.08, you can now move the top section using a 'coarse adjust' (/\/\) and 'fine adjust' (^).
- 5) When satisfied, stitch the next intervals by repeating steps 2-4.
- 6) When complete, click the **View Composite** radio button to generate and view the final results.

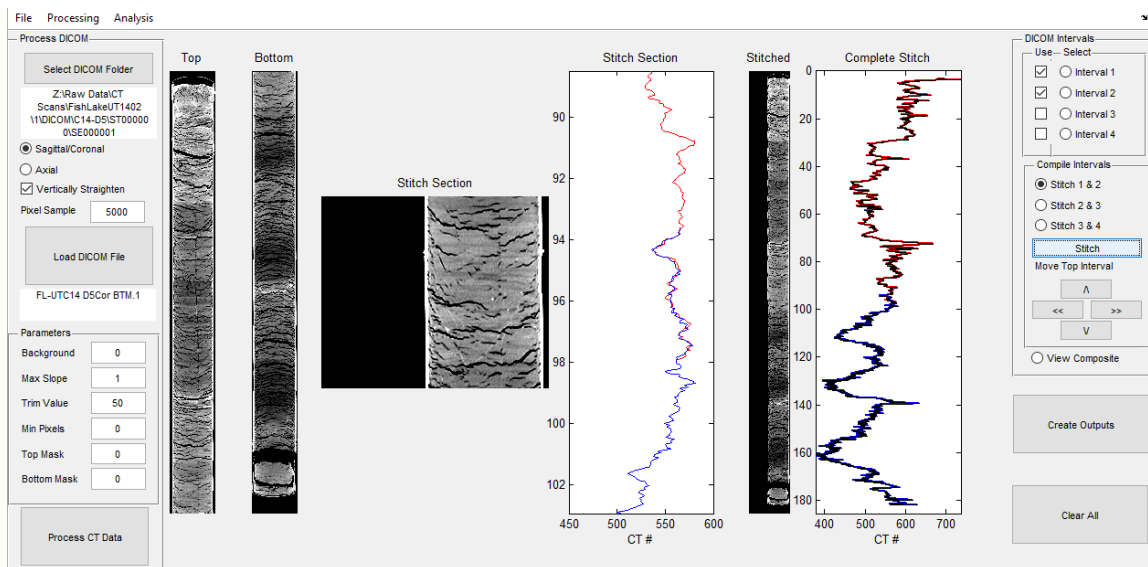
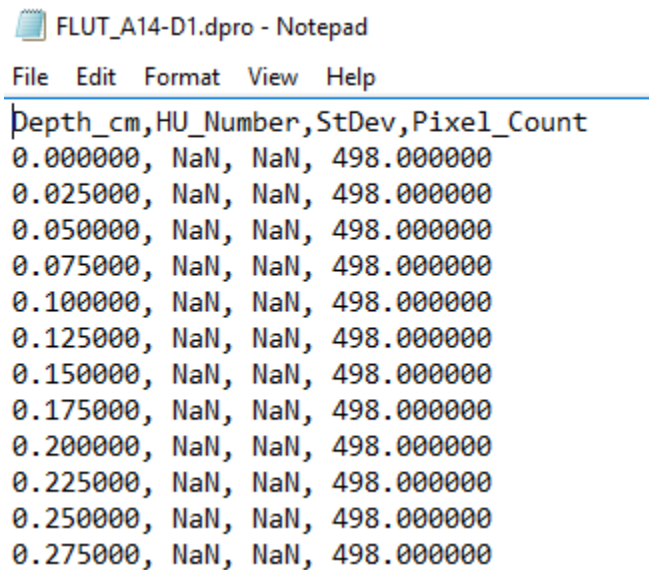


Figure 4. Stitching together a ~1.8 meter sediment core that was run in two intervals.

Create Outputs:

- 1) Click **Create Outputs** and create/select directory to save the results. The results will include a comma delimited *.dpro file with the down core numeric profile (Figure 5) and an unscaled *.tiff file.
 - a. The *.dpro can be opened in excel or any other program of your choice. No values are indicated as **NaN**. If opening in excel, you will need to use the 'Find and Replace' function to replace NaNs with blank cells



```

FLUT_A14-D1.dpro - Notepad
File Edit Format View Help
Depth_cm,HU_Number,StDev,Pixel_Count
0.000000, NaN, NaN, 498.000000
0.025000, NaN, NaN, 498.000000
0.050000, NaN, NaN, 498.000000
0.075000, NaN, NaN, 498.000000
0.100000, NaN, NaN, 498.000000
0.125000, NaN, NaN, 498.000000
0.150000, NaN, NaN, 498.000000
0.175000, NaN, NaN, 498.000000
0.200000, NaN, NaN, 498.000000
0.225000, NaN, NaN, 498.000000
0.250000, NaN, NaN, 498.000000
0.275000, NaN, NaN, 498.000000

```

Figure 5. *.dpro comma delimited file format.

- b. The unscaled *.tiff can be opened and manipulated in programs like Adobe Photoshop™. For suites of unscaled *.tiff, you can use **SedCTImage** (accessed by typing SedCTImage into the MATLAB command line, see below) to quickly produce scaled CT images with quantitative gray scale values for suites of cores. Note, the *.tiff generated at this stage will generally appear all black when opened by most image viewing software.
- 2) Once core is completed, click **Clear All** to clear data and start another core.

Using SedCTImage:

- 1) Once you have processed your CT scans for a core or suite cores, **SedCTImage** helps produce quantitatively scaled *.png images that can easily be used in presentations, publications, or reports.
- 2) Open MATLAB and type **SedCTImage** in the command line and hit enter. The SedCTImage (GUI) will open in a new window.
- 3) Click **Select *.dpro.tiff Directory** and select the folder containing your SedCT outputs. The cores will be listed in the white box below this button (Figure 6a).
- 4) Click **Process** (Figure 2b). The scaled images will appear to the right (Figure 2c).

- 5) Use the circular radio buttons next to the **Process** button to toggle between **Gray Scale** images and **False Color** images.
- 6) Use the **Scale Marks** check box to include 5 cm scale ticks in the exported product.
- 7) Set the upper and lower range CT values by entering the desired value in the white box and clicking the **Upper Range** and **Lower Range** buttons.
- 8) Export the suite of gray scale or false color *.png images by clicking the **Save GS** and **Save FC** buttons. Exported file names will include the upper and lower range of CT values in the image.
- 9) False color and gray scale bars are included with SedCT that can be used in programs like Adobe Illustrator to display the quantitative scaling of your image. Additionally, an Adobe Illustrator file is included which has a depth scale that can be used with the exported SedCTimage *.png files.



Figure 6. The SedCTImage GUI