Introduction
In this exercise, you’ll be using the fully-prepared example data to explore the basics of FUSION.

Prerequisites
- Successful completion of Exercise 1 (Download and Install FUSION and the Example Data set)

Overview of Major Steps
1. Start Fusion and Load the Example Lidar Data
2. Load a Reference Image
3. Select a Sample to View in LDV
4. Add a Bare Earth Model
5. Explore FUSION’s Sampling and Display Options

Procedure

Part 1: Start Fusion and Load the Example Lidar Data
1. Start Fusion: Click Start | Programs | FUSION | FUSION
2. Click the Raw Data button on Fusion toolbar to display the Open dialog box.
3. Navigate to your data folder (C:\lidar\SampleData\) and Select the sample dataset (lda_4800k_data.lda) and Click, Open. This will open the Data Files dialog.
4. The Data Files dialog allows you to change the display Symbology of the lidar data in the Fusion window—but, we strongly recommend that you accept the defaults (especially the Symbol set to None) for now, Click, OK (read the sidebar before making any changes).
5. Save your Fusion project by Clicking the Save icon or File | Save As.
6. Name the project exer02.dvz and Save it in a new folder named C:\lidar\Fusion_Projects.

If you change the Symbology by setting a Symbol other than None and you click the check box next to the Raw data... button, all of the data points will display in the Fusion window. This may be entertaining and educational once but you won’t want to do it often—and it is not necessary in order to use FUSION.
Part 2: Load a Reference Image
1. Click the Image button (located on Fusion toolbar). Select the sample orthophoto (orthophoto_4800k.jpg) from the sampledata folder and Click, Open. The image will automatically display in the Fusion viewer. If you want to zoom-in to any part of the image, Right Click on the location you want to zoom to. Zoom-out by Clicking the Zoom to extents button.
2. You’re now ready to view the lidar data in the Lidar Data Viewer (LDV).

Part 3: Select a Sample to View in LDV
To create a sample and view the corresponding Lidar data in 3D:
1. Position the cursor over an area of interest in the orthophoto, Left Click and drag a smallbox (called a stroked box) over the area and release the left mouse button—this is your sample. Note: a small sample works better (faster) than a large sample.
2. The sample box will be highlighted in the Fusion viewer and LDV, Fusion’s 3D viewer, will automatically appear and load the Lidar data within your sample boundary, as in the figure to the right.
3. Use the Basic LDV Navigation Tips (sidebar) until you are comfortable with your ability to...
Part 4: Add a Bare Earth Model

1. Close the LDV and return to FUSION (it will still be running & your last sample will be displayed).
2. Click the Bare earth button (located on the Fusion toolbar).
3. Select the sample terrain model (4800K_ground_surface.dtm) from the sampledata folder and Click, Open.
4. Within the Surface model options window, you can accept the defaults or define contour intervals and line colors. Once you have chosen intervals and colors or accepted the defaults, Click, OK. The terrain model will be displayed in the Fusion viewer as a contour map over the orthophoto.
5. Click the Repeat last sample… button (located on the Fusion toolbar). This will display the same lidar data cloud as before—but in a moment we will also view the bare earth surface...
6. Right Click within the LDV viewer to access the “Right Click Menu”.
7. Click on Surfaces (or use the Alt-U keyboard option). The bare earth surface will automatically display with your lidar data cloud.
8. Access the right-click menu again and Click on Data to toggle the data off (or type Alt-D). This will allow you to inspect the bare earth surface without the data cloud. To turn the data back on use the right click menu and Click on Data again.

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Part 4: Explore Fusion’s Sampling and Display Options

Fusion offers a number of ways to sample and view lidar data. We’ll explore several of these options in this section and you’ll use many of the remaining options in subsequent exercises.

1. In the FUSION window Click the Sample options button to open the Sample Options dialog (see Appendix 1).
2. Under the Sample shape section, Select, Stroked circle (the default is Stroked box) and Click, OK.
3. Select a small stroked-circle sample in the Fusion window and view the results in the LDV.
4. Close the LDV.
5. Return to the Sample options and change the sample shape back to Stroked box.
6. In the Decimation section, increase the value to 200 and Click, OK.
7. In the Fusion window Select a large stroked-box sample (suggestion: make the stroked box cover about 1/2 the size of the reference image). It may take a few minutes to extract the sample but the results display very fast in LDV. Please notice that the ground is not flat within the sample area as you view the data in LDV—you’ll make it flat in the next sample.
8. Return to the Sample options and Select (check) the Subtract ground elevations from each return in the Options section and Click, OK.
9. Click the Repeat Last Sample button. This will repeat the last sample area but now the data will appear in LDV on flat terrain—this is very useful for comparing heights above ground level.
10. Return to the Sample options and change the Decimation value back to 1 and de-select the option to subtract ground elevations.
11. Select the Bare Earth Filter option to Exclude points close to surface and increase the tolerance to 2.
12. Click, OK to close the sample options dialog.
13. Select a small stroked box sample in the Fusion window. Note that the points close to
    the ground have been excluded from displaying in LDV.
14. Return to the Sample options and Select the Include all points option under Bare Earth
    Filter.
15. In the Sample options window, under the Color options Select, Color using image and
    Click, OK.
16. Click the Repeat last sample button. You should notice that each lidar return is now
    painted the color of the corresponding reference orthophoto image. Keep LDV open.

To this point, you’ve been controlling the display and sample options from Fusion’s Sample
Options dialog box. Now, we’ll explore a few of the display options within LDV...
17. Access the right-click menu and Toggle (either on or off) the Draw all points when
    moving option. Click-and-drag to move the data sample. If you’ve toggled the Draw
    all points... option on, the responsiveness of your display may be sluggish (but it looks
    good) and if you toggle the option off, the LDV display will be very responsive (but it won’t
    look as good).
18. Set the Draw all points... option to suit your computer and your preferences.
19. Access the right-click menu again and Click the Marker... option.
20. Experiment with the Marker Type and Marker Size options—however, be aware that the
    sidebar note is particularly applicable to some of the Marker Types. If in doubt, keep the
    marker type set to Points.
21. Back in the Fusion window, Click the Sample Options button.
22. Enable the Color by Intensity option.
23. Click, OK and then Click, Repeat Last Sample. The LDV viewer will display returns ac-
    cording to their intensity value (or the near-infrared spectral value). The intensity informa-
    tion can be helpful to interpret ground features. However, because the intensity informa-
    tion of the ground features are clustered on only a small portion of the displayed intensity
    range, the default display parameters make the data difficult to interpret. Let’s adjust the
EXERCISE 2: GETTING STARTED WITH FUSION

To visually interpret the intensity values more effectively you will need to truncate your histogram to the values that contain most of your data values. In this example, we will truncate the histogram to a maximum of 30 and a minimum of 1.

Max Intensity Value=30

Min Intensity Value=1

intensity display parameters to improve interpretation.

24. Click the Histogram checkbox on the left side of the LDV viewer (see graphic to left). The histogram will display (black) along the color legend.

You should see that most of the intensity values are clustered in the lower half of the available intensity range. Let’s truncate the available range to the approximate range of the intensity values (so that we can interpret the LiDAR data better).

25. Write down the approximate low and high intensity values that capture most of the histogram (see graphic to left).

26. Click the Sample Options button in the Fusion window.

27. Enable Truncate Attribute Range (in the Color section).

28. Enter your approximate minimum and maximum histogram values.

29. Click, OK and then Click, Repeat Last Sample.

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Now that you’ve effectively stretched your intensity data to cover the full color legend for improved interpretation (see figure to the left). High intensity values (or high near-infrared values) for natural communities most likely represent photosynthetically active vegetation, and in some cases may represent dry bare soil. Lower intensity values likely represent: 1) wet, bare soil, 2) water, or 3) less photosynthetically active vegetation. The figure to the left illustrates how the data and histogram changes with truncation.

To conclude this exercise, continue to interact with the data in LDV and experiment with the following items on the right-click menu:
- Wiggle-vision (Alt-W)
- Overhead View (Alt-O)
- Reset Orientation (Alt-R)
- Reset Zoom (Alt-Z)
- Image Plate (Alt-P)

32. Turn the truncate function off and choose the color by option that seems most appropriate for general visualization (color by height is recommended).
33. Save the project: File | Save.

This concludes Exercise 2
The only option in the **Options** section that we’ll explore in this exercise is **Subtracting ground elevation from each return**. This essentially flattens the terrain so above-ground feature heights can be readily interpreted. Note this is where we can toggle the option to Snap our sample to a POI.

The default **Sample shape** is a Stroked box, but there are other options. Of particular interest: A Fixed circle is very useful for defining fixed radius plots (when choosing a fixed box or circle, you will have the option of specifying the size). The fixed circle can be snapped to the plot center by choosing the **Snap** option in the **Options** section...

Enabling this option can allow you to truncate (or stretch) your histogram so that your data display is more interpretable.

Once we have specified a Bare Earth Model and/or a Canopy Surface Model, we can filter (include or exclude) lidar points at a user-defined distance from those surfaces.

The **Decimation** option allows you to reduce the density of the points being sampled. This is especially useful when you select a large sample area.

The **Color** options (though they’re not really sampling options) allow you to display the data by a number of attributes. Usually the most useful option is **Color by height** but we will also explore **Color using (reference) image** and **Color by Intensity**.