

Tutorial 2 – Data Pre-Processing

Welcome to this tutorial in which we will look at how to prepare raw tire data for fitting in OptimumT. In this tutorial you will learn how to:

1. Crop raw data and use crop templates
2. Using the Collapsing Tool
3. Used collapsed data to enhance graphs

1. Cropping Data

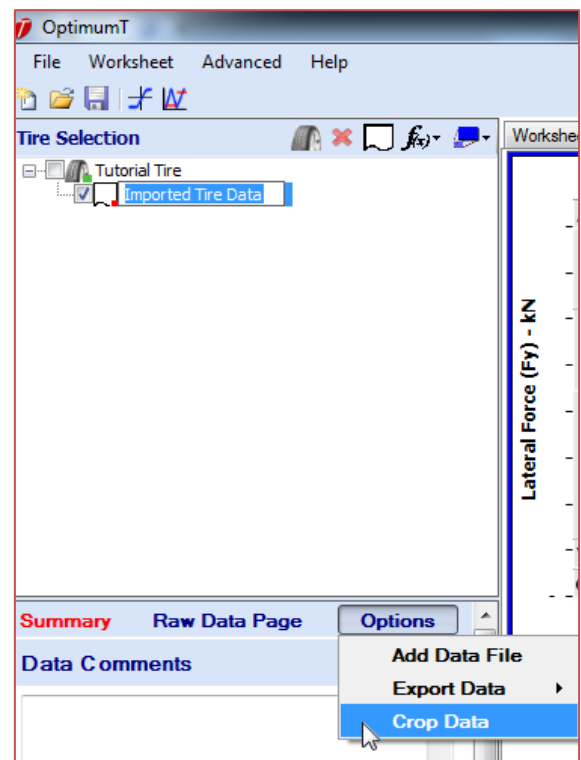
In order to make the tire fitting process as efficient as possible, OptimumT was designed to take care of all pre-processing tasks involved in tire fitting. This means that you can import raw data files coming straight from the tire testing facility without having to use another software first.

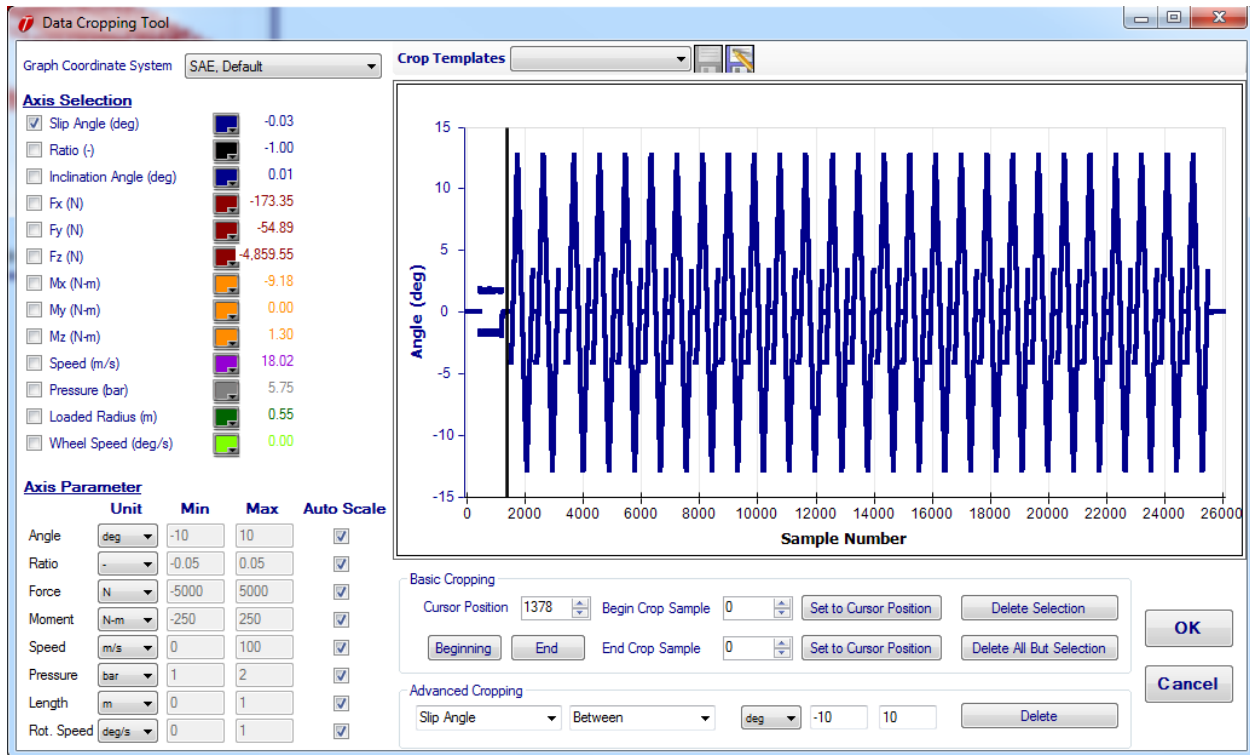
The first part we will look at is data cropping. What that means is removing unwanted data. “Where is unwanted coming from?” you might wonder, an example is the warming sequence which typically takes place before each test run. We don’t want to have these data points included in our tire model, which is why we want to remove them. We will be using the same data as in Tutorial 1, where we looked how tire data is imported into OptimumT.

Click on the data file in the tree to the left. Then go further down and in the *Options* menu, select *Crop Data*. This will bring up the *Data Cropping Tool*. In the window you find a *Report Graph* which allows us to look at all the data points in the order in which they were collected. We can use the panel to the left to turn on and off different channels.

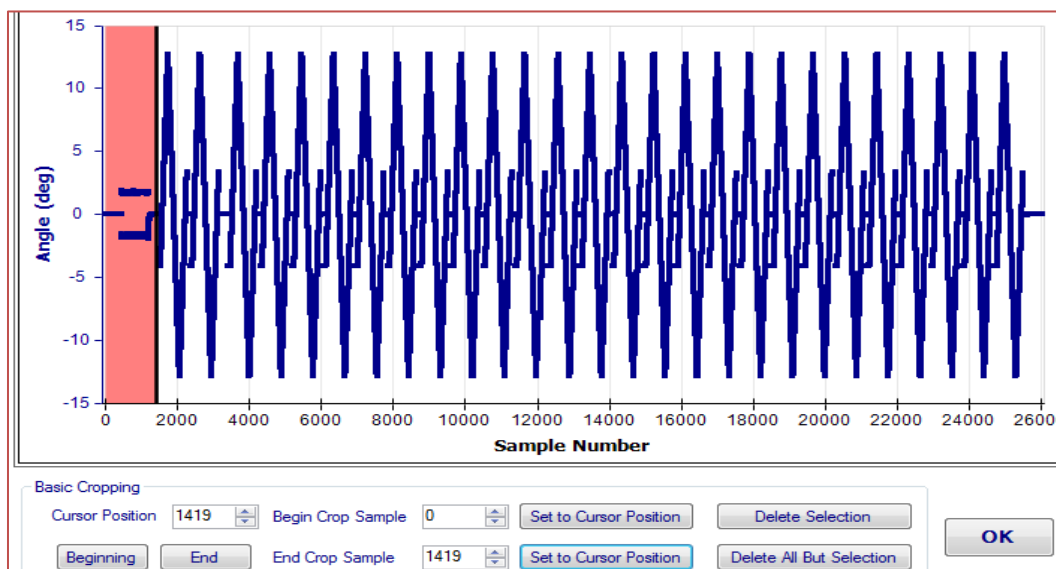
The cropping controls are located under below the graph window. We will start by looking at the basic cropping tool and will then look at the advanced tools.

The basic cropping tool allows us to delete parts of the data that we don’t want. We know from the last tutorial that we don’t want to have the warm up data. We can see the warm up data in graph, from around sample number 0 to sample number 1500.

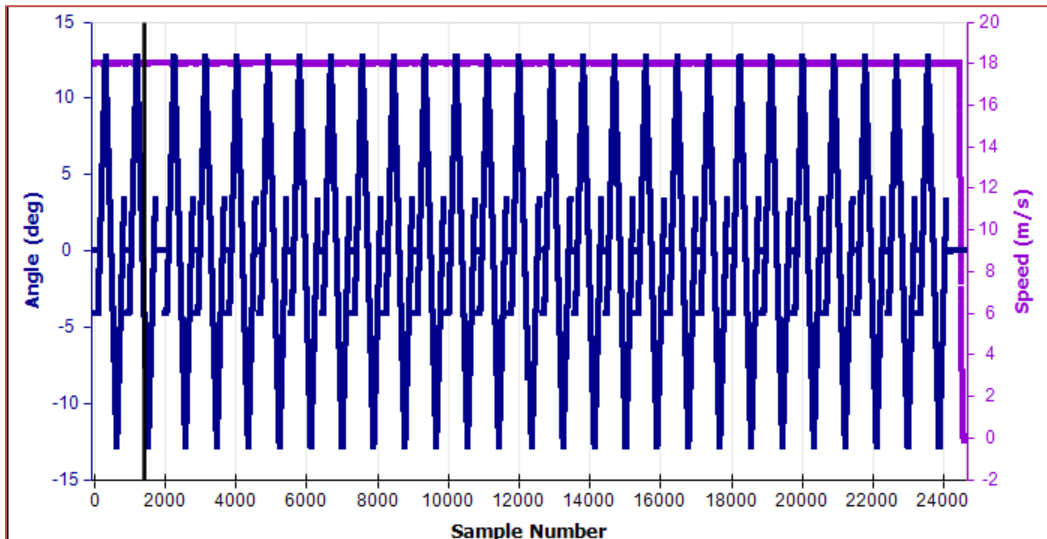




Now that we know approximately which area we want to crop, we can place the data cursor (the black vertical line) where the warm up sequence stops. We can use the data values in the left panel together with the *Cursor Position* toolbox to step the cursor back and forward. We do this until we find the position where the first slip angle sweeps starts. Once we have found that spot, we press the second *Set to Cursor Position* button. This will set the *End Crop Sample* to our current position. We enter 0 for the *Begin Crop Sample*, this means that we have marked all samples between 0 and around 1400. The selected area will be highlighted in red. To remove this highlighted data, we just click the *Delete Selection* button.

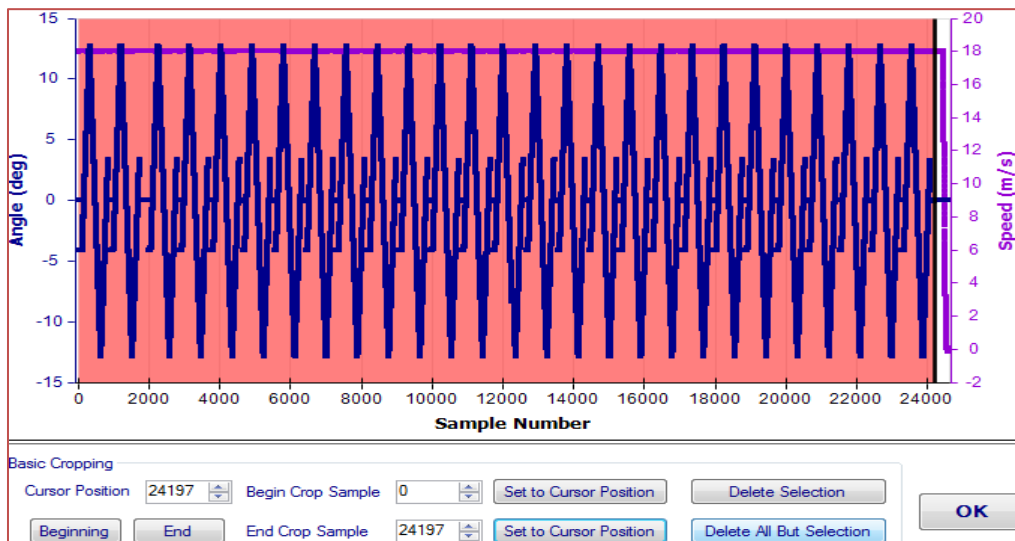


Great, we have now cropped the warm-up sequence! Let's see if there is other data we want to remove. Will turn on the *Speed* channel to see the speed of the tire, we do this by click on the checkbox by *Speed* in the panel to the left. We will now see a bright purple trace of the speed.



We can see that the speed is constant during the test at around 18 m/s. But we also see that the machine stopping and the tire is slowing down at the end of the test. After around sample number 24000 the speed quickly drops to zero as the machine stops. We don't want to include this data.

When cropping this data, we will use a slightly different technique. At first, we position the marker where the speeds starts to drop, as in the previous case we use the *Cursor Position* control to adjust the position while keeping an eye at the speed channel value. We will then click the button so that the *End Crop Sample* is where the speed starts to drop. We will manually enter 0 as the *Start Crop Sample*. Now all of our "good" data will be highlighted red. Clicking *Delete All But Selection* will delete the data that is not highlighted. In this case this is what we want, click it and got rid of the data at the end.



As you probably figured out, I could have done all this cropping in one step. By having the *Start Crop Sample* where the warm up sequence stops and the *End Crop Sample* before the machine started slowing down. This would have saved us some time, but as matter of fact, by using a cropping template we can save even more time. If you have test data for the same tire at two different pressures, having to do the cropping twice will be quite boring. Just create a cropping template for the first, and then automatically apply it to additional data you import. You just have to make sure that the same test sequence has been used for the data.



Let's take a look how this is done! When we are done with all the cropping, just press the *Save Template* button. Enter a name for the template. Next time you open a data file generate with the same testing sequence, just select the saved template and all the cropping operation will be performed. A great time saver!

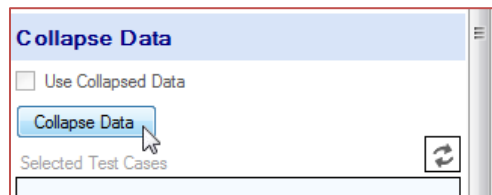
Lastly, the advanced crop tool (found at the bottom of the *Data Cropping Tool*) can be used to crop data based on recorded values (such as slip angle or camber) rather than sample numbers.

2. Collapsing data

The last pre-processing step we want to do before getting into fitting tire models to the data is to collapse the data. Collapsing the data has many advantages, these are:

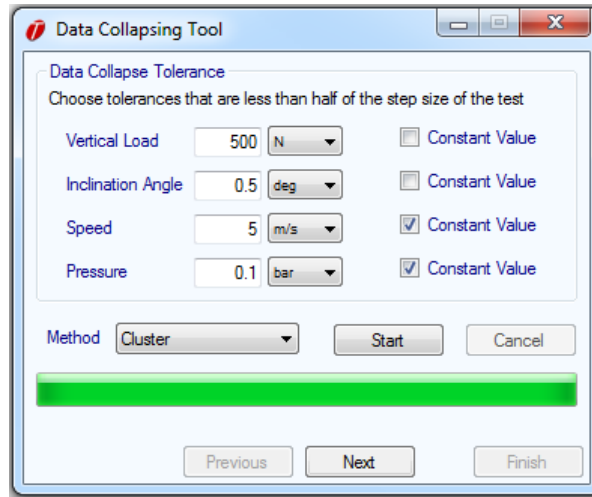
- Reducing testing hysteresis from data
- Consolidating number of data points which will speed up fitting
- Identifying test cases which will help with visualization of the data

The collapsing tool is obviously a pretty great thing, so let's get to it! First thing we do is that we select our freshly cropped tire data in the tree on the left side of the screen. The scroll down the panel until you get to the Collapse Data section, just click *Collapse Data* to get started.

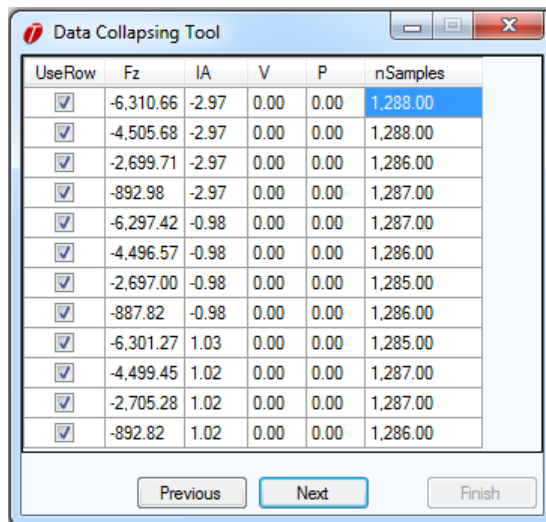


This will bring up the first window of the *Data Collapsing Tool*. In this window we will have to select the tolerances for the collapsing. Typically we want these to be less than half the step size of the test. For example, if we have tested camber at 0° and 2° and 4° we want the tolerance for inclination angle to be less than 1°. The same principle applies for vertical load, speed and pressure. In case one of these are constant for the test, like in our case where both pressure and speed was constant. We can then check

the *Constant Value* for these. This will speed up the collapsing as the software will not try to find isolated test cases for these variables. Once we are done, we can hit the *Start* button.



OptimumT will now process all the data points and remove hysteresis and identify test cases. Once the process is done, the green progress bar will reach 100% and we can hit *Next* to continue.



In this case we can see that the collapsing went well, we can see how OptimumT successfully identified 4 different vertical loads (Fz) and 3 inclination angles (IA). In this case where I used Newton as force unit, the vertical loads are approx. -6300 N, -4500 N, 2700 N, -890 N.

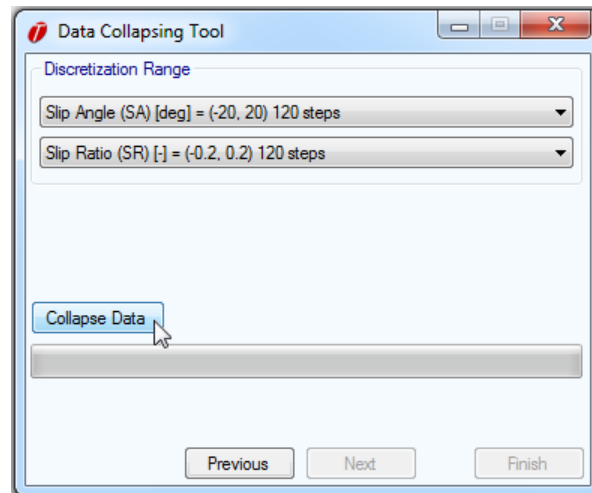
We can also see that the number of samples (*nSamples*) in each testing condition is the close to the same. If the input data is very noise, you might have to press *Previous* and adjust the tolerances to ensure a good data collapsing. You can do so as many times as you want. When you feel like you

Did you know:

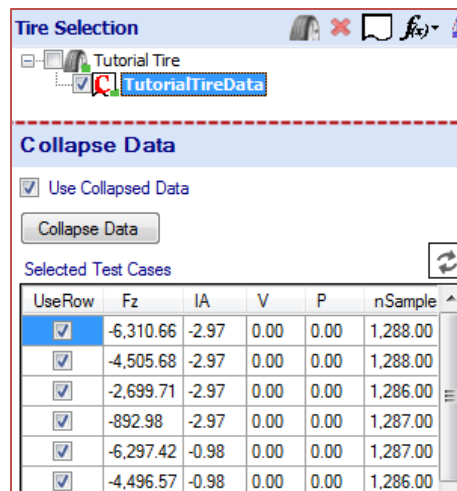
Working with different units in OptimumT is a breeze, easily change the units in all inputs/outputs as you prefer. OptimumT will take care of all conversions!

have good results, click the *Next* button to continue.

In the next step you can select the discretization range for the collapsed data; typically you can leave the default values. What this does is that it reduces the data points according to the discretization parameters. In some case you might want to change this, please review the help file for more information. In any case, click the *Collapse Data* button and then the *Finish* button to finish the process.



When looking at the data in the tree you will now notice that there is a big *C* in the tire data icon. This means that the tire data is collapsed. Further down in the panel you can see all the different Test Cases. By using the checkboxes you can turn on/off any test case in both plots and fitting. That way you can easily control which test data you want to use. You uncheck the *Use Collapsed Data* button to show/use the original data.

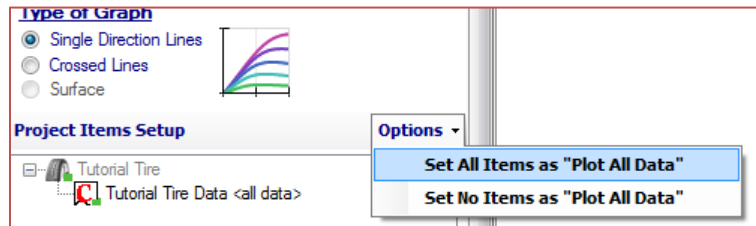


We have now successfully collapsed the data. In the next step will review the results of this process when we use the collapsed data to enhance the plots.

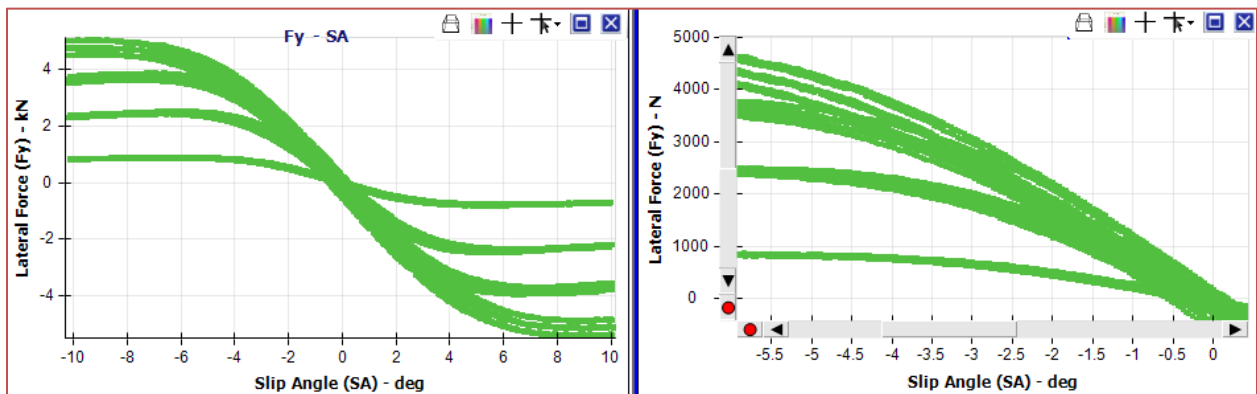
3. Using collapsed data in graphs

Ok, so we got the data imported, cropped and collapsed. Let's take a better look at the data then!

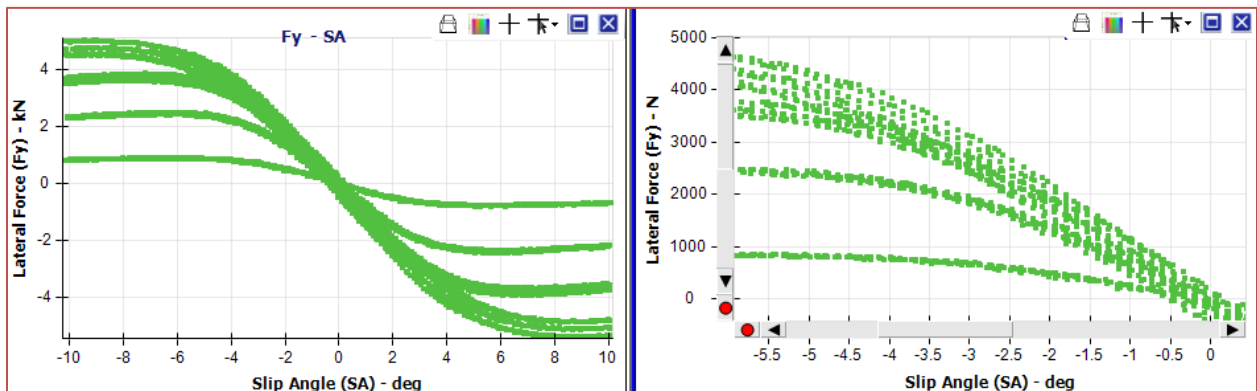
We are now going back to the graph we created in the first tutorial (a F_y vs SA graph). First we just need to make sure that OptimumT shows all the data. Select the graph and in the panel in the left, scroll down and click *Options* and then *Set All Items as "Plot All Data"*. This is a good setting to check if you find yourself not seeing any data.



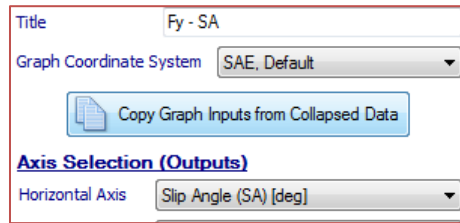
Now that we got all data displayed, the unprocessed data looked something like this (full view on the left, zoomed in on the right):



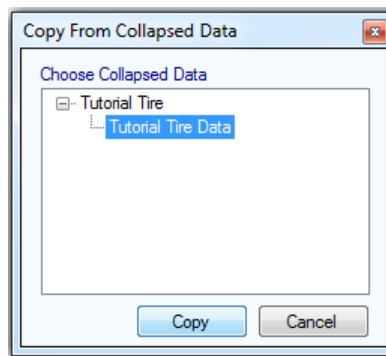
After we have collapsed the data, we can see how the number of data points has been reduced. But the integrity of the data is maintained. Remember that we can switch between collapsed and un-collapsed data using the *Use Collapsed Data* checkbox.



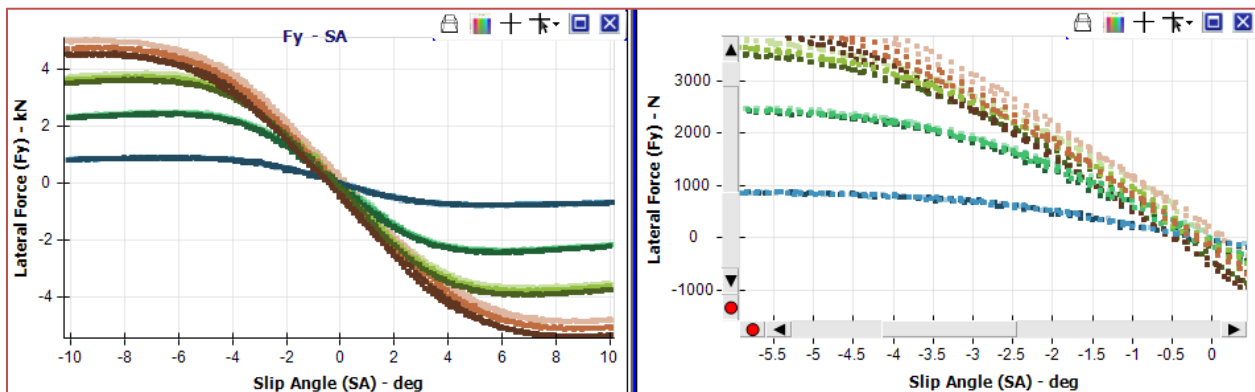
Now we are going to use the collapsed data to color the graph after the different test cases, the process is really quite simple. With graph activated, just look for the *Copy Graph Inputs from Collapsed Data* button.



Click that button and in the following pop-up window, select the collapsed data. In our case we will only have one set of collapsed data to choose from. Mark it and click *Copy*.




At first you might not see a difference, so now we need to change the graph settings once again. This time we will want OptimumT only to show the data specified by the collapsed data. Go to the *Options* button and select *Set No Items as "Plot All Data"*. You should now have a colorful graph that will show the different test conditions.




The last thing we are going to try in this tutorial is to turn off/hide some of the test cases. We go back and click on our *Tutorial Tire Data* in the tree. We look in the panel for the *Selected Test Cases* grid view. Then click on the header for the row *Fz*, this will sort all the test cases based on vertical load. We can see

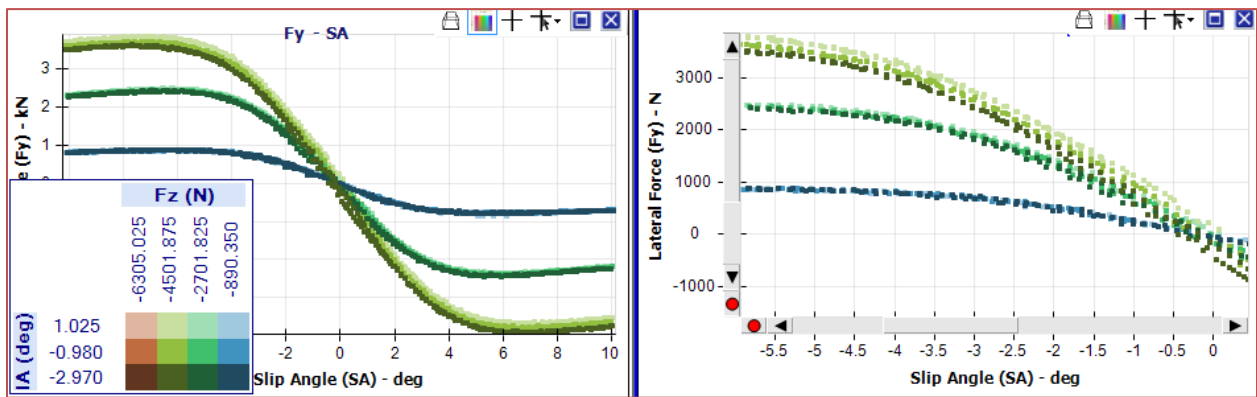
that we have three cases at about 6000 N vertical force. Uncheck these boxes, and then click the refresh button.

Uncheck these test cases 

UseRow	Fz	IA	V	P	nSample
<input checked="" type="checkbox"/>	-6,310.70	-2.97	0.00	0.00	1,288.00
<input checked="" type="checkbox"/>	-6,301.30	1.03	0.00	0.00	1,285.00
<input checked="" type="checkbox"/>	-6,297.40	-0.98	0.00	0.00	1,287.00
<input checked="" type="checkbox"/>	-4,505.70	-2.97	0.00	0.00	1,288.00
<input checked="" type="checkbox"/>	-4,499.50	1.02	0.00	0.00	1,287.00
<input checked="" type="checkbox"/>	-4,496.60	-0.98	0.00	0.00	1,286.00

Refresh the graph with this button 

You should now have a graph that doesn't show the highest load (red). We can also turn on the graph legend by turning pushing the colorful box in the upper-left corner of the graph window. You should now have something that looks like this:



That's all for this tutorial, we have learnt how to pre-process the data (cropping and collapsing). We also learnt how we can use the collapsed data to enhance our graphs. In the following tutorials, we will fit a tire model to our data and we are going to learn more on how to work with the powerful graphing tool.