2012 Ford Fusion Brake Testing With iPhone Accelerometer - Test #17 Partly on Gravel Shoulder

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This article is the third in a series of four articles discussing emergency braking tests performed by Gorski Consulting with a 2012 Ford Fusion passenger car equipped with multiple video cameras and the tri-axial acceleration displayed from an iPhone 4S cell phone. In the first article of this series we introduced the instrumentation that was used in the testing and analysis of the data. In the second article we discussed the results of a simple emergency braking test on a dry, tar and chip road surface. The present article and a fourth one will discuss the results of a more complicated braking test where the right side wheels of the test vehicle are riding on the right gravel shoulder of a rural highway when the braking begins.

The test being discussed in the current article took place while travelling westbound on Medway Road, a few kilometres east of Clarke Road, just north-east of London, Ontario, Canada. The test was performed on the afternoon of February 24th, 2013 when the outside temperature was near zero degrees Celsius. The test speed was at 71 km/h.

The photo below shows a front view of the rest position of the 2012 Ford Fusion test vehicle after the braking test was performed and the vehicle was steered off the road surface to prevent interference with road traffic.

The photo below shows a westbound view along the north asphalt edge of the highway. The foreground shows the location where the right side tires of the vehicle exited the paved road surface prior to the braking test.

A tire mark in the middle of the gravel shoulder of the above photo was pre-existing and not relevant to the testing. The photo below shows an easterly view looking toward the point where the two right side tires of our test vehicle exited from the paved road surface. When our vehicle is steered the right front tire exits first, followed by the right rear, so that the two tires do not follow the same path, so we see the marks from both tires on the shoulder.

Stepping back further to the west, the photo below shows another view looking east at the marks caused by the two right side tires.

Turning around to face westward again, the photo below shows the tire marks on the right shoulder at a location where the vehicle has now been positioned squarely in a parallel direction to the road and the braking can begin.

Looking at the previous photo it might be difficult to detect where the braking commenced. But by zooming in and using a longer focal length the tire mark can be compressed in length as shown below, and differences in the character of the tire marks might be better visualized.

Certainly, in the foreground of the above photo the tire marks maintain the visible treads within them, then as we look further into the background we can recognize some disruption within the tire marks. The photo below gets us closer to that area of disruption.

Roughly in the middle of the above photo we can still see some remnants of the tread pattern but we also see some lifting and disruption of the resting position of the gravel. The photo below shows a closer view of the disruption and we can see how the gravel has been turned up while the tire tread is difficult to detect.

As the braking proceeded the test vehicle began to rotate counter-clockwise. Thus the right rear tire began to track along a different path from the right front tire. Evidence of this action can be seen in the photo below.

In this photo it may be possible to detect the tracking of the right rear tire which displays a disruption of the gravel which is the full tread width. Just to its right is the partial width of disruption caused by the right front tire. The reason for this happening is that the mark produced by the right front tire is driven over top of by the right rear tire. Although these observations are not easily detected it is possible to decipher them with some close study of the photo. The separation of the tire marks may be more visible in the photo below which shows them at a location further to the west.

As we rotate around to look westward again the photo below shows the paths of the two right side tires near the end of the braking test with the mark of the right front tire on the left and that of the right rear tire on the right.

The photo below is taken from the point where the right front tire came to a halt in the foreground, near the asphalt edge. The gentle curving path of the right rear tire mark travels toward the bottom left corner of the photo. An unrelated, pre-existing tire mark is also visible to the left of that right rear tire mark.

It can be seen above how the softened mud of the shoulder was "squeezed" to the outside edges of the right front tire mark at the point where it came to rest. Then there is a sharp change in direction of the right front tire mark as we steer to the right to park our vehicle off the road surface. The disruption of the tire tread pattern is visible in the portion of the right front tire mark where braking was taking place and we can contrast that with the clearly delineated tread pattern that is visible in the tire mark in the portion where the vehicle is steered, without braking, to a parked position.

Similarly, the characteristics of the right rear tire mark in the foreground are of a rolling tire because the right rear tire came to a halt further to east in the background. So in the foreground the right rear tire is rolling as part of the action of being steered to a parked position. Thus the tire tread is clearly delineated within this tire print.

When we look closely at the point where the right front tire came to a stop at the end of the braking test the characteristics are shown in the photo below.

And again in the photo below it is possible to see the mud being squeezed to the outside edges of the tire mark. We can also see the transition between the end of the skidding and the point where the change in direction occurs from steering the vehicle to its parked location.

The photo on Page 15 is a westward view showing the right side tire marks at the end of the braking test as well as beyond to the point where we see the rear end of the parked test vehicle. By following the path of the two right side tire marks west of where they came to a stop it can be seen how they converge and then match up to the right side tires of the parked vehicle in the background.

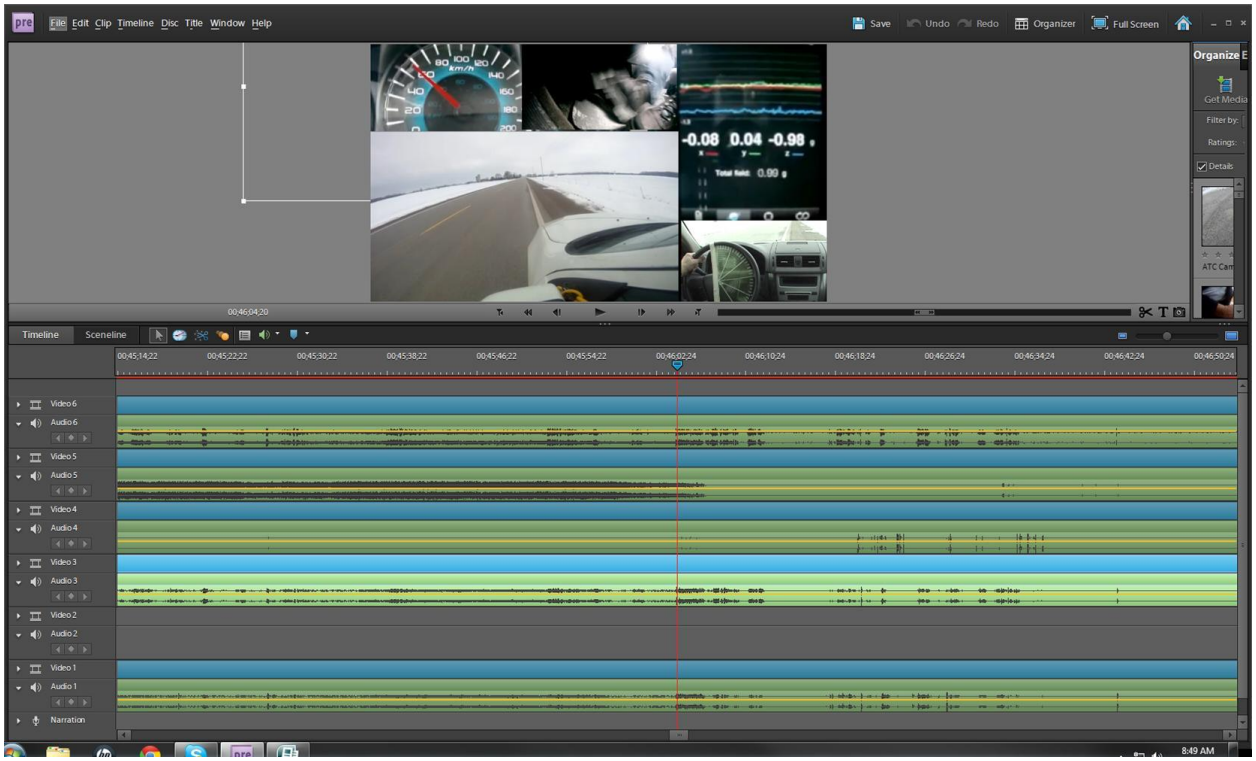
So it is clear from examining the tire mark characteristics that they show how the test vehicle rotated counter-clockwise as the braking was taking place. This is not surprising as the two left side tires were on the more aggressive surface of the asphalt pavement. During emergency braking the right side of the vehicle wanted to slide further forward than the left side and therefore this rotation occurred. The rotation was sufficient to take the front end of the vehicle back toward the paved road surface. One might also present a good argument that the tire marks may also show that the total mass of the vehicle was directed back toward the paved road surface. This result is interesting particularly when we look at the steering employed in the test as demonstrated in some of the video footage which will now be studied in the Premiere video project.

Analysis of the Test With the Premiere Video Project

We have already introduced the instrumentation in the first article of this three-part series.

Below is a Print-Screen capture of our computer screen on which we have uploaded the Adobe Premiere video-editting project from our testing. Another screen capture at the top of Page 17 shows the same information as the photo below. These two views demonstrate how we can adjust the size of the area showing the videos versus the area showing the tracks. In the photo below the area showing the video has been reduced while the area showing the tracks at the bottom has been increased. The green/blue linear bands at the bottom of the photo are the individuals tracks representing the video and audio from all five cameras. Conversely the photo at the top of Page 17 shows how the area showing the videos has been enlarged while the area showing the individual tracks has been reduced. This adjustment allows us to study either the content of the videos or the content of the tracks, or a little bit of both depending on our specific interests.

The screen capture view at the bottom of Page 17 shows how a "Full Screen" adjustment can be employed where everything on the computer screen is removed expect the views from the five video cameras.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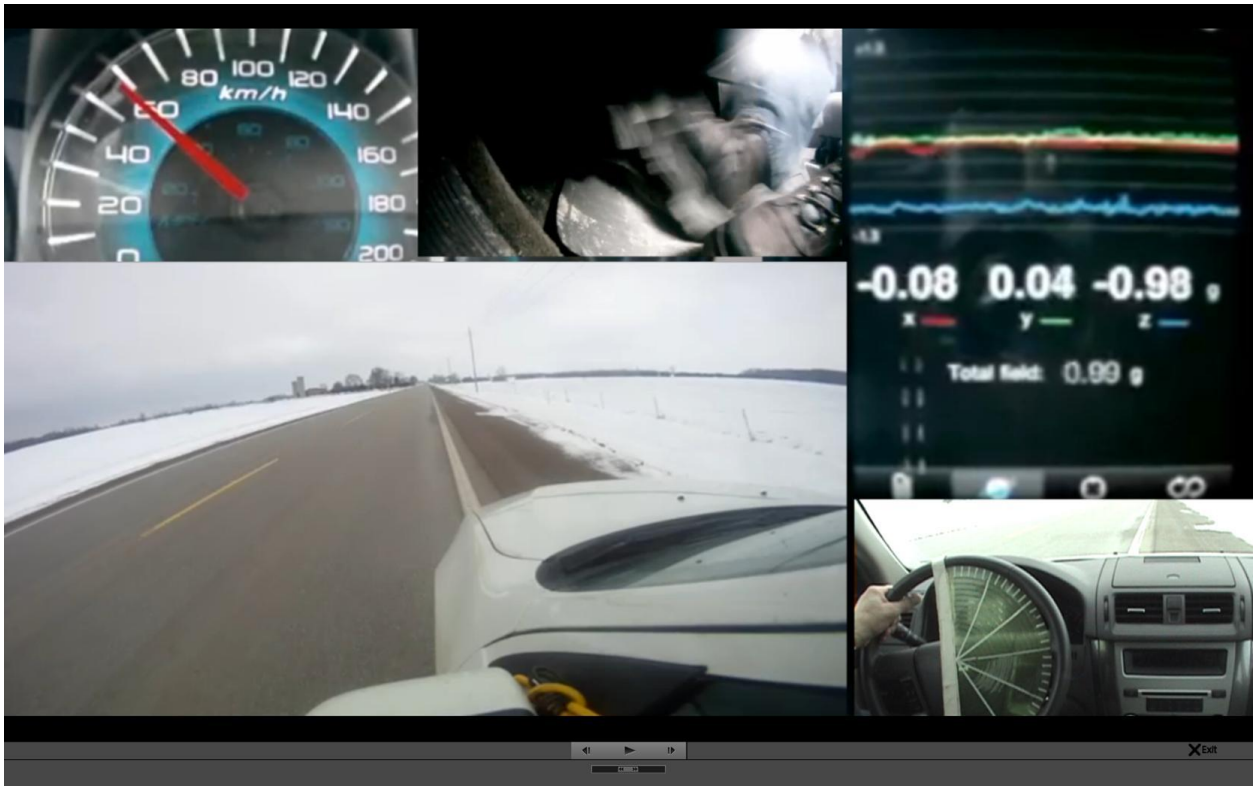
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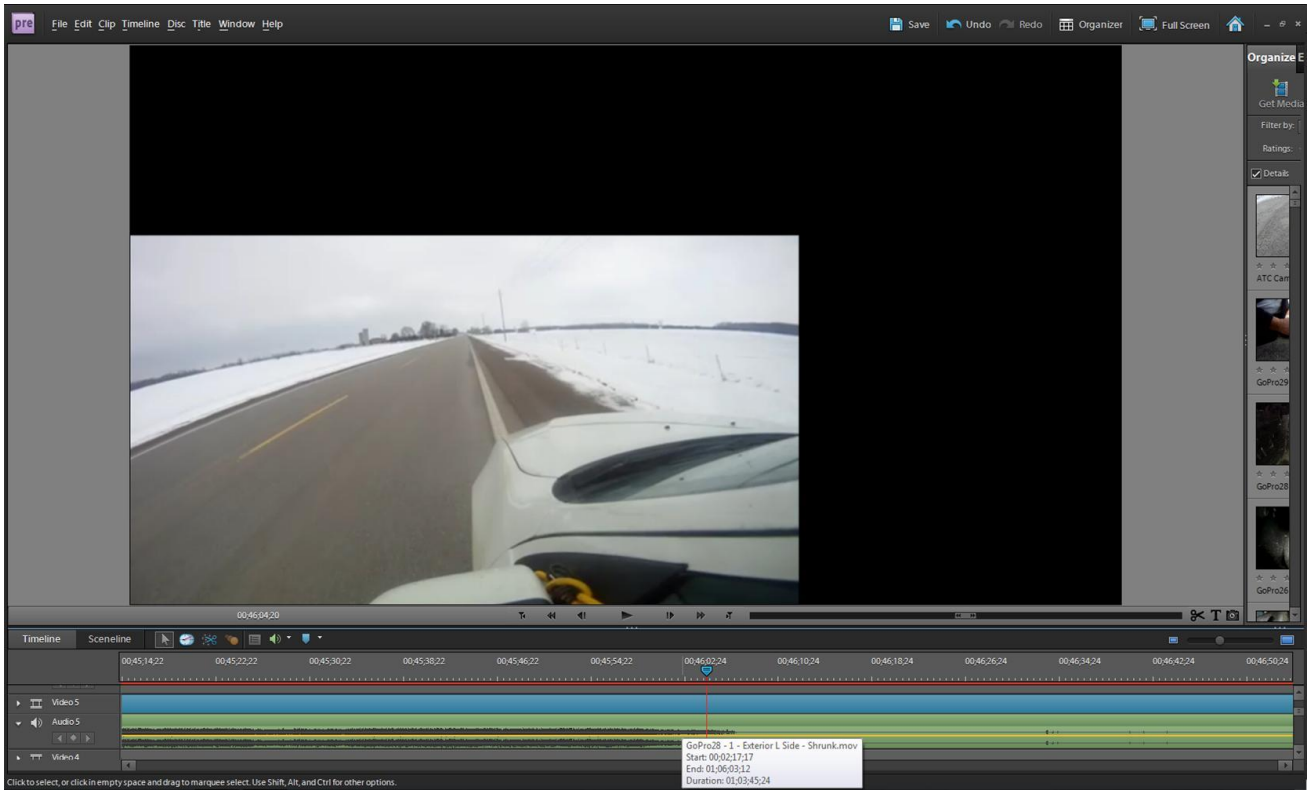
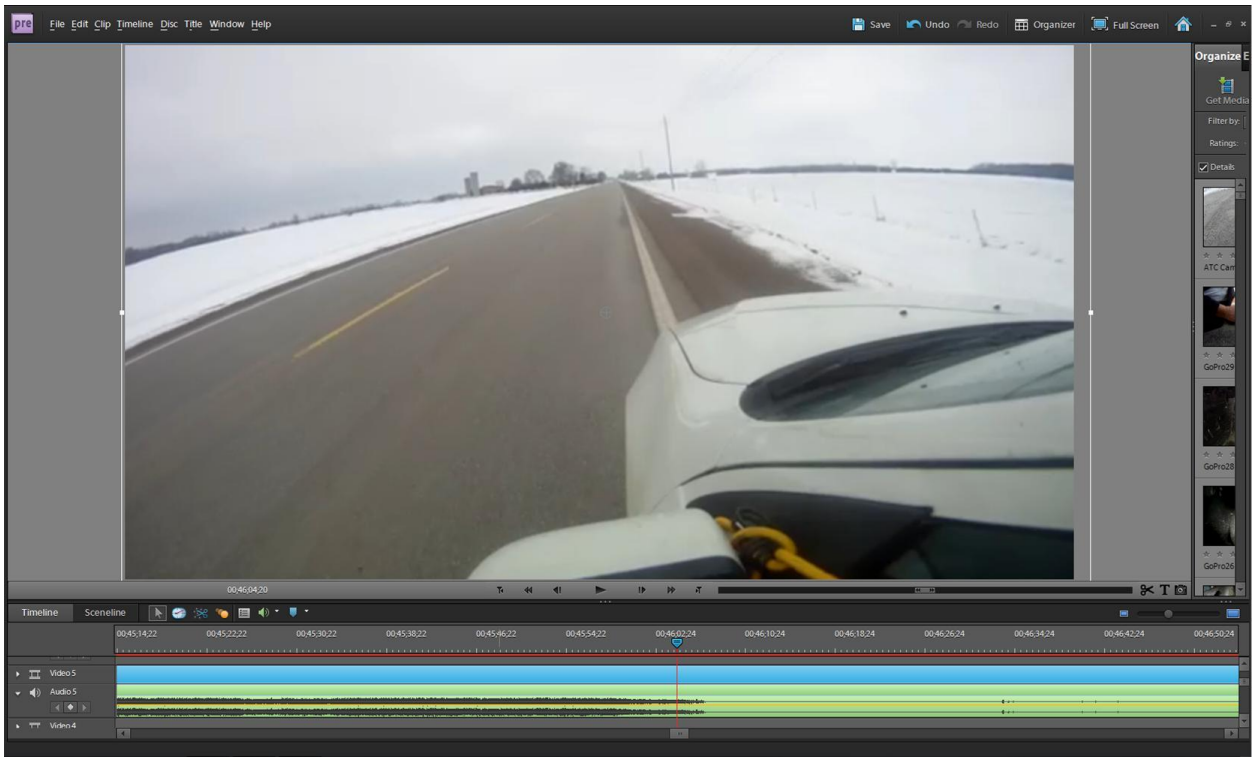
Furthermore, adjustments can be made to display the view from just a single video camera by shutting of the views of the other four and then enlarging the view from the single camera. For example below we see the computer screen as we shut off the views from four of the cameras so that the single video from the exterior of the driver's window is the only one that is active.



Next, at the top of Page 19 we show how the view from the single remaining camera can be enlarged to fill the computer screen.

Additionally, the remaining video can be enlarged even more to highlight some portion of the video that we might be interested in, as shown in screen capture view at the bottom of Page 19. This view might be of importance because as the vehicle begins to rotate during our braking test we would be interested to know when the rotation begins. This close-up view shows us the white edge line of the westbound lane and how it lines up with the left hood edge of the vehicle. Now, as the vehicle begins to rotate those two references will change such that the left edge of the vehicle's hood will no longer be in line with that white edge line. So this is how we can track various actions by studying certain portions of a single video in detail, or by looking at the videos from several cameras.

Not only this, but we can also look at the information in the audio tracks to give us further information about some aspects of the testing. At the top of Page 20 we show how the area showing the tracks from each of the video cameras can be expanded so that we can see the tracks from each of the five video cameras.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Video 5
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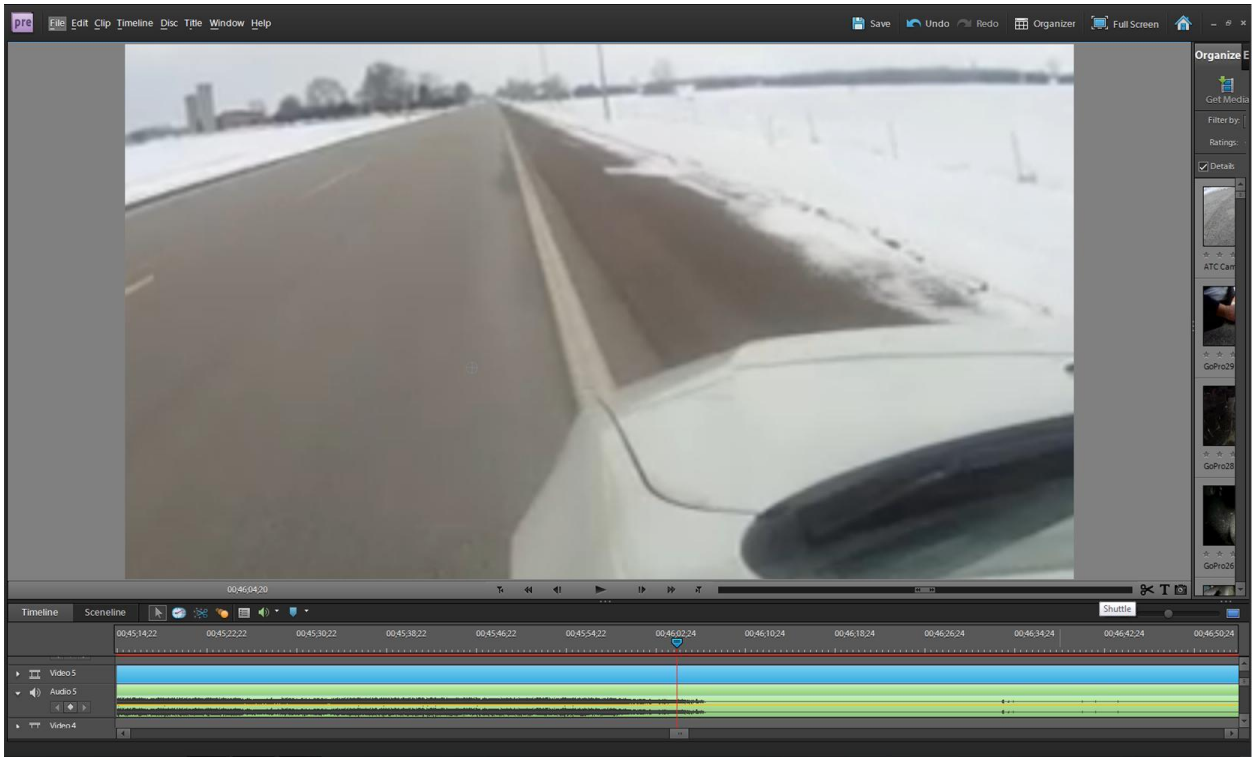
Video 4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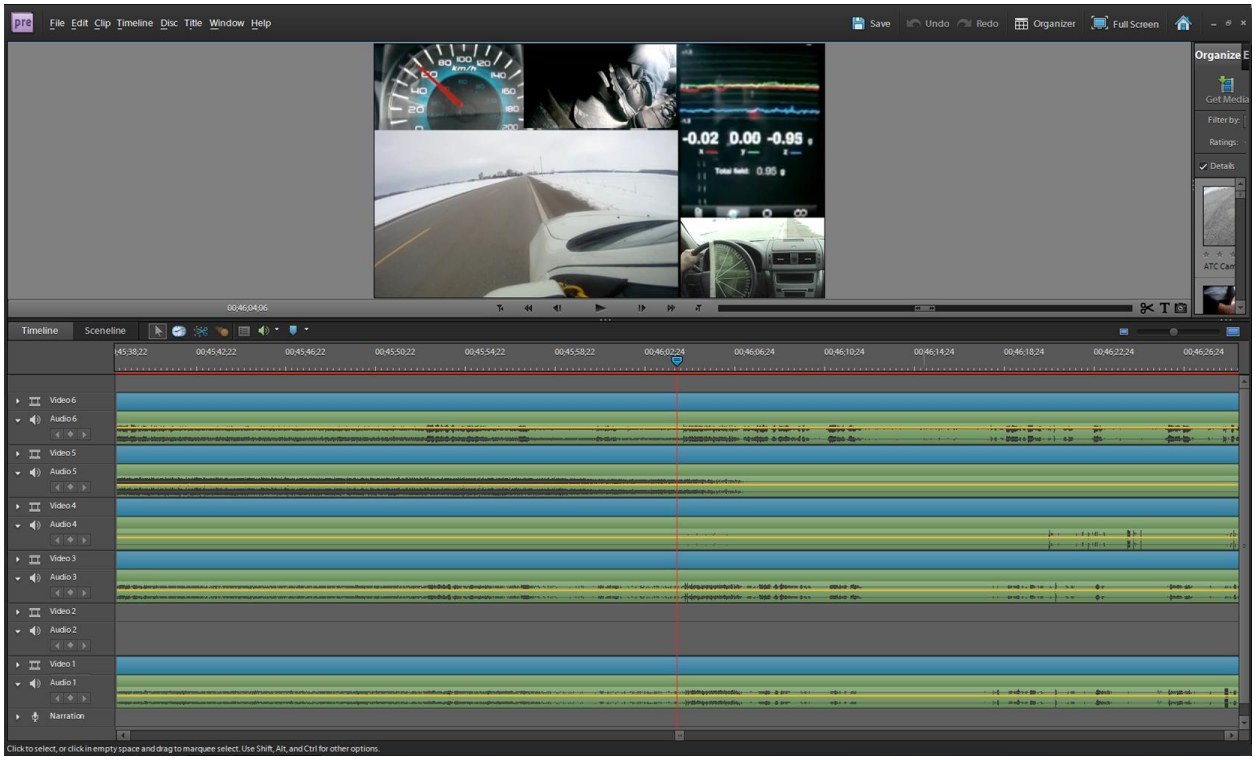
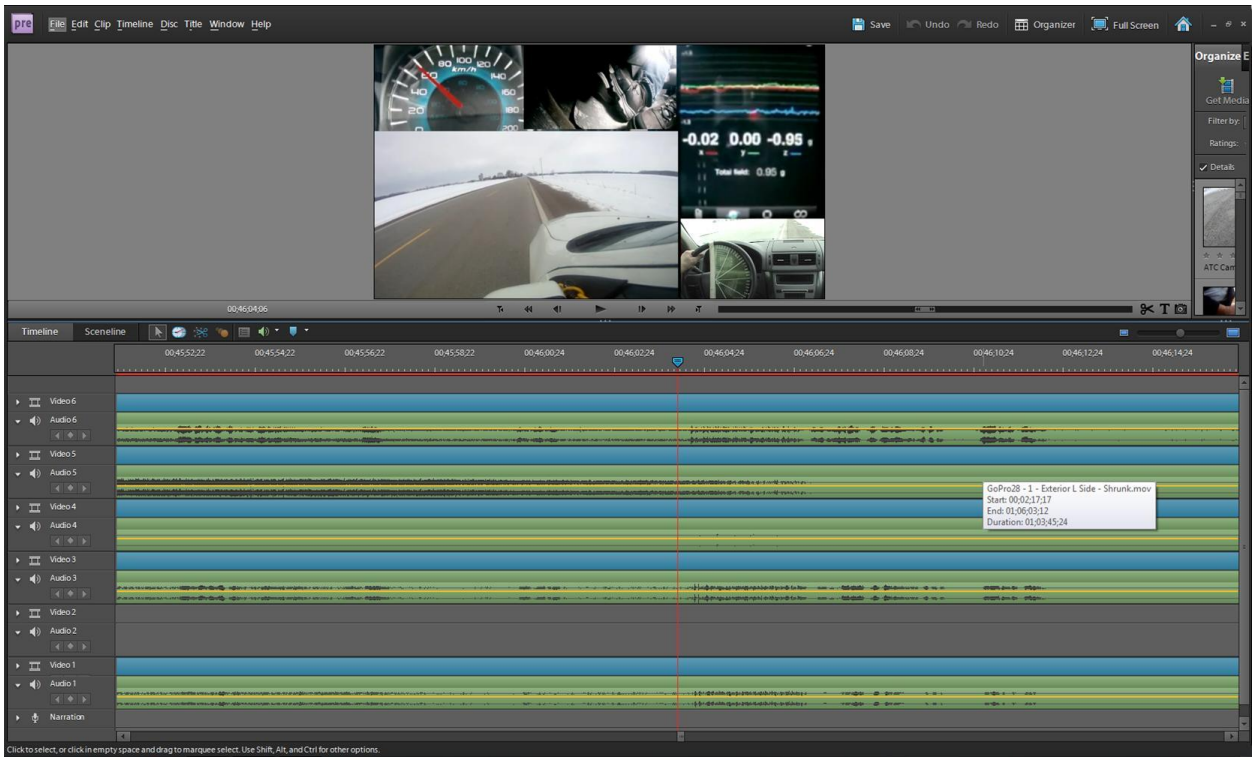


If you look closely in the middle of the green/blue tracks in the above screen capture view, you will be able to see a red vertical line. This red line indicates the present position along the tracks that is being displayed in the video area above. The light green horizontal bars are the audio tracks and some black markings within those audio tracks are the audio "noise" that has been recorded on each camera.

The above view is the condition just before the brake pedal is depressed in our test. So the red vertical line is just approaching an area of recorded noise from the braking action that can be seen in the tracks of three of the cameras. Looking from the top, the three tracks that display that noise is the top track, the fourth track and the fifth track. Note that the recorded noise has an identical signature in the audio tracks of all three cameras. That area of noise can be expanded to show more details and this expansion is shown in the screen capture view at the top of Page 21. And we expand the detail even further in the screen captures shown at the bottom of Page 21 and at the top of Page 22. The precise method we use to synchronize all the video cameras is to line up these specific signatures of recorded noise so that they all occur at the same time in each of the tracks shown above.

Different cameras will record different noise depending on their location on the test vehicle and the study of the details of this noise can provide additional evidence to the analyst about certain aspects of the testing. After some experience the analyst is able to recognize the noise that is typically generated from human voices, the passing of other vehicles, indications of braking, etc. without even looking at the content of the video recordings shown in the upper portion of the screen.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Audio 5
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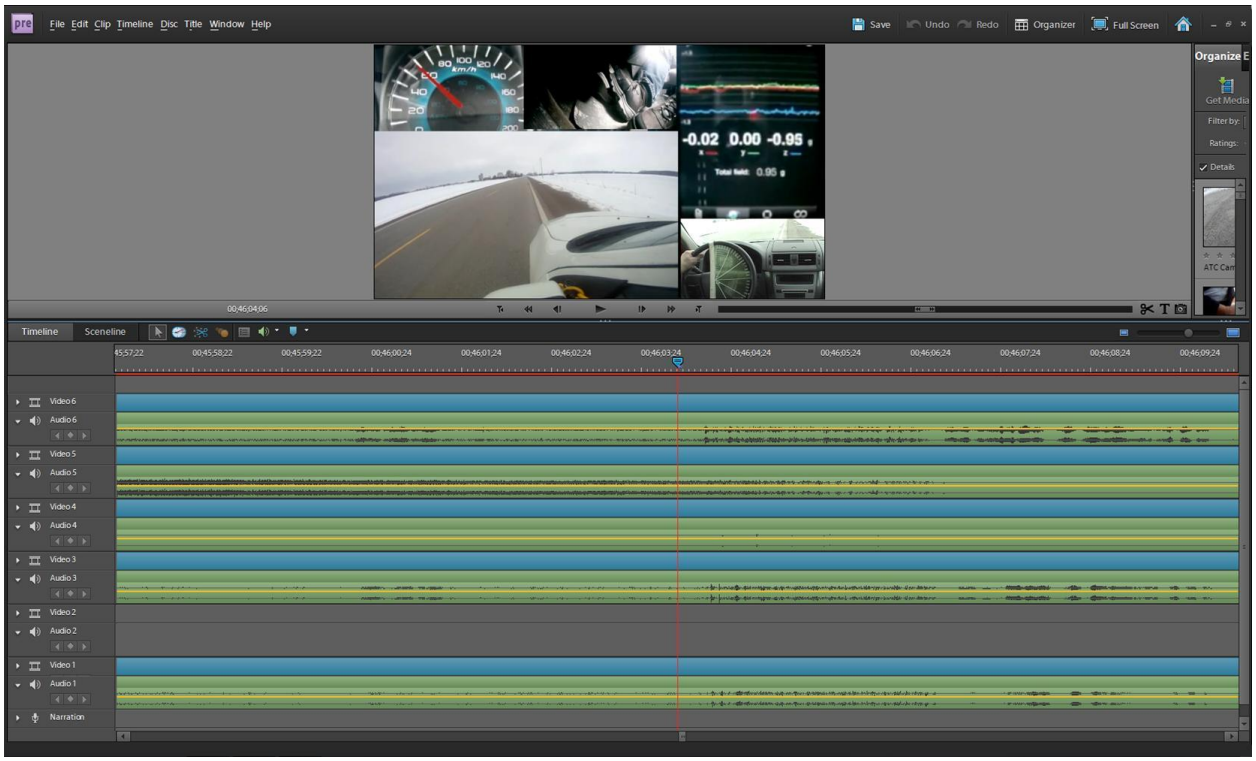
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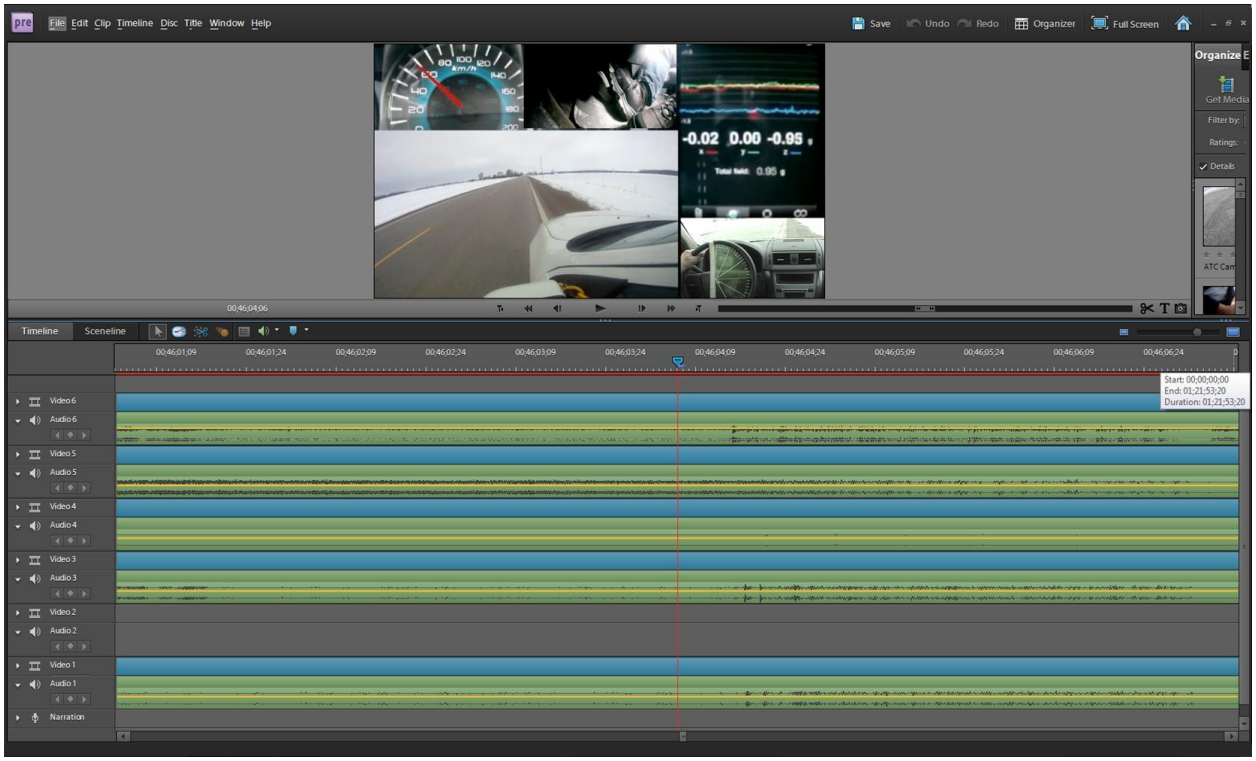

Given the amount of space taken up by the display of the various photos of the tire marks and the screenshots this article has become too long to proceed with the full extent of analysis that we intend to discuss. Thus further details about the analysis will continue in the fourth and final article in this series.

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