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Results from the first two pilots of the physical testing

Loughborough University Design School (LDS): Design Ergonomics Research Group

Research Sponsored by Transport for London and the UK Department for Transport

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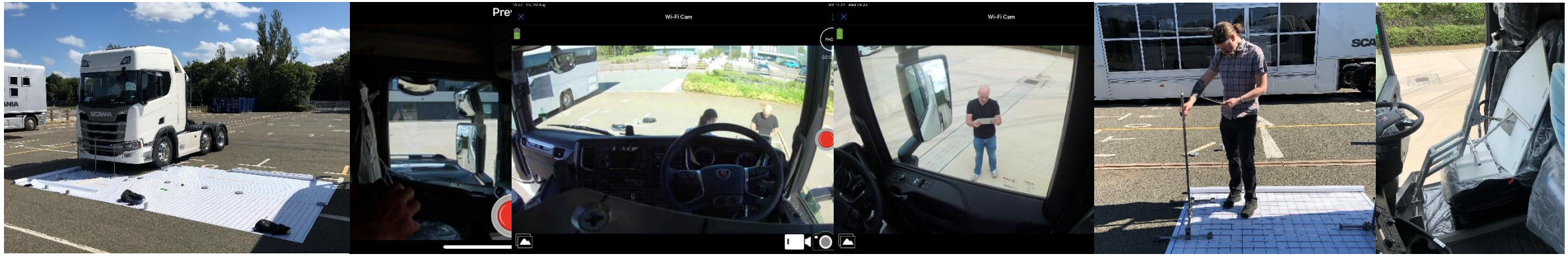
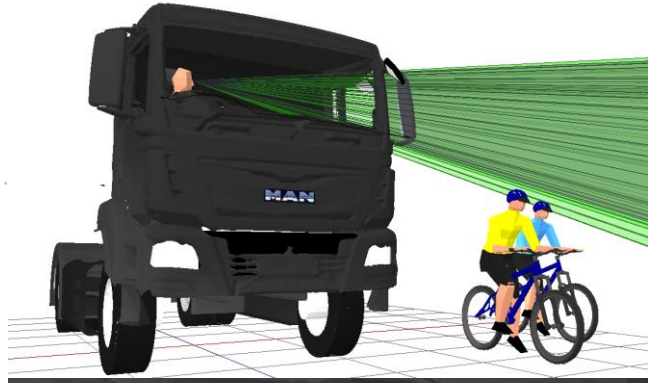
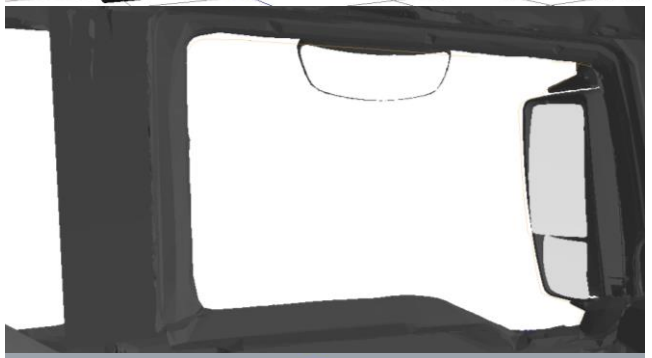
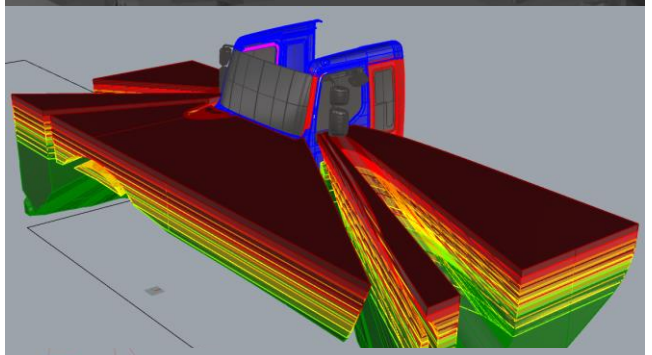


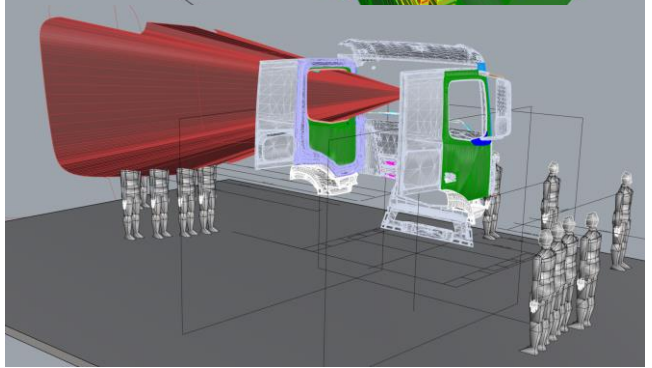
Contents

- Back ground to the physical testing method
- Pilots conducted
- Results for the Volvo FM
- Results for the Scania R
- Proposed Improvements to the process
- Summary







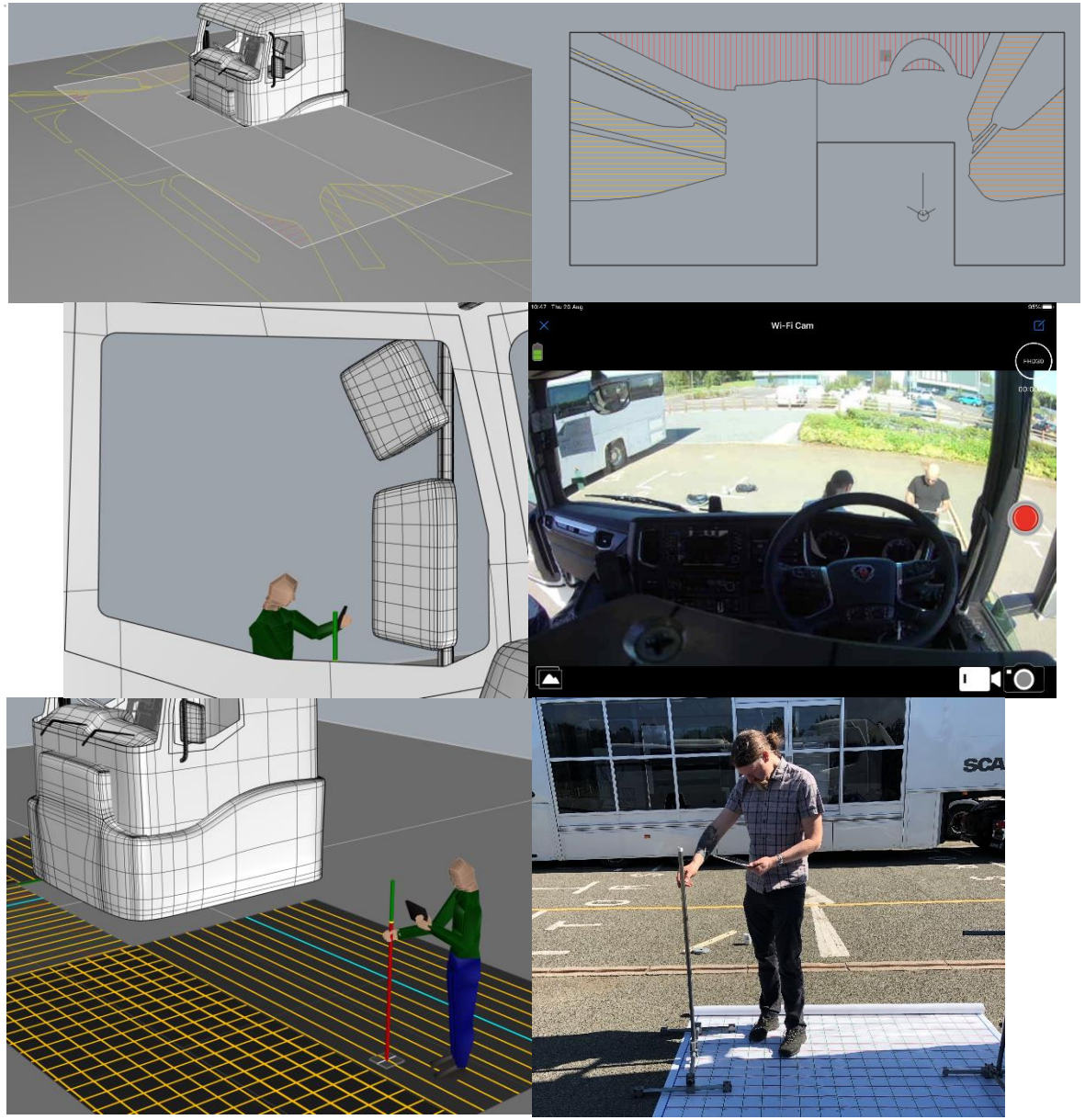


Background – Physical test method

- The UN ECE VRU Proxi group requested a physical test that can be used to complement the digital test that is used to measure direct vision performance.
- Work was performed to develop a method which produces results which are equivalent in accuracy to the digital method.
- A number of different techniques have been explored over the past year.
- The method that has been piloted has the following characteristics.

Background – Taking a section through the volume

- The physical testing technique that is being developed effectively gathers data that is a **section** through the visible volume.
- This section is taken at a height which is equivalent to the neck height of a 5th%ile Italian Female (1267mm) to reflect the previous use of VRU simulations to quantify the volumetric scores produced by the TfL DVS.
- It is taken by marking a floor grid with the locations at which the top of a stick with a height 1267mm can be seen in a camera view from the eye position
- This produces a set of line lengths which are simply summed

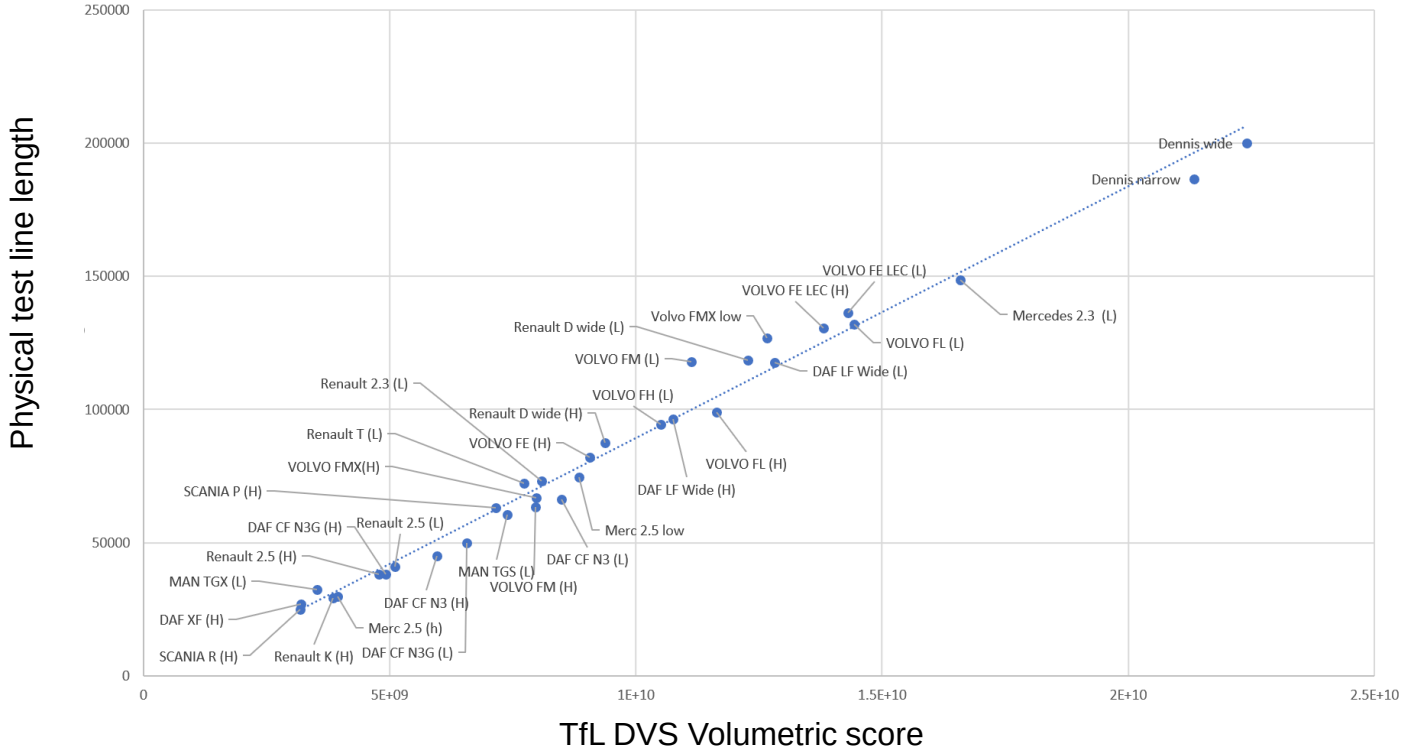


Background – Digital simulation of the physical testing results correlated with the digital testing results

- As discussed above the use of the physical test **defines a section** of the portion of the assessment volume visible to the driver and we would therefore expect there to be a high correlation between the volumetric approach and the physical testing approach

- Our simulations have shown that the correlation is **almost perfect** with a correlation coefficient of 0.992

- This result is for measured lines taken every 100mm



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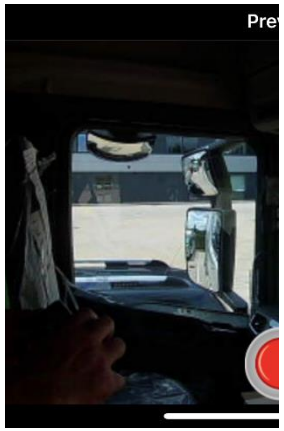
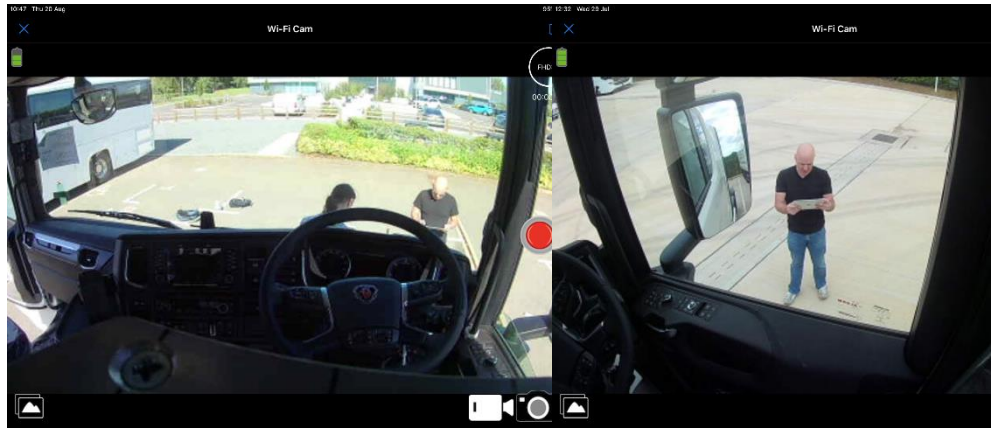
Background – Eye rig

- The eye positions that have been defined in the digital DVS have been recreated with a specific rig

- WIFI cameras are located with their lenses exactly at the eye point locations required using specific 3D printed camera mounts providing a view that can be used externally on a tablet computer





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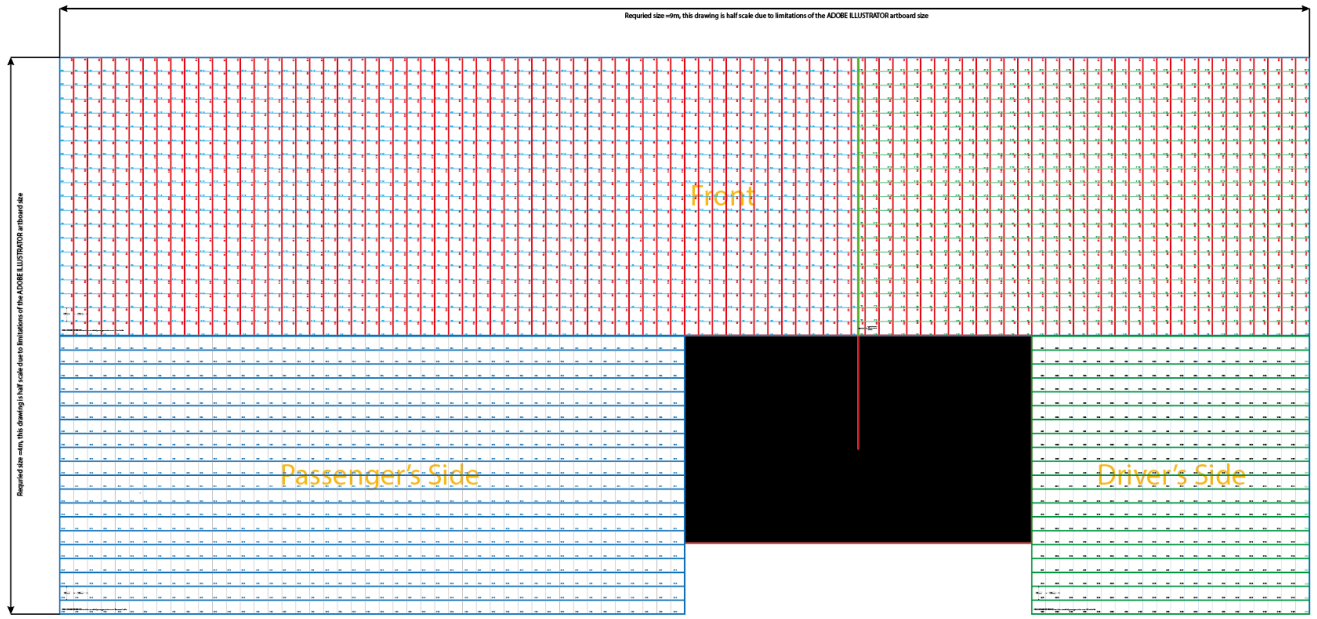
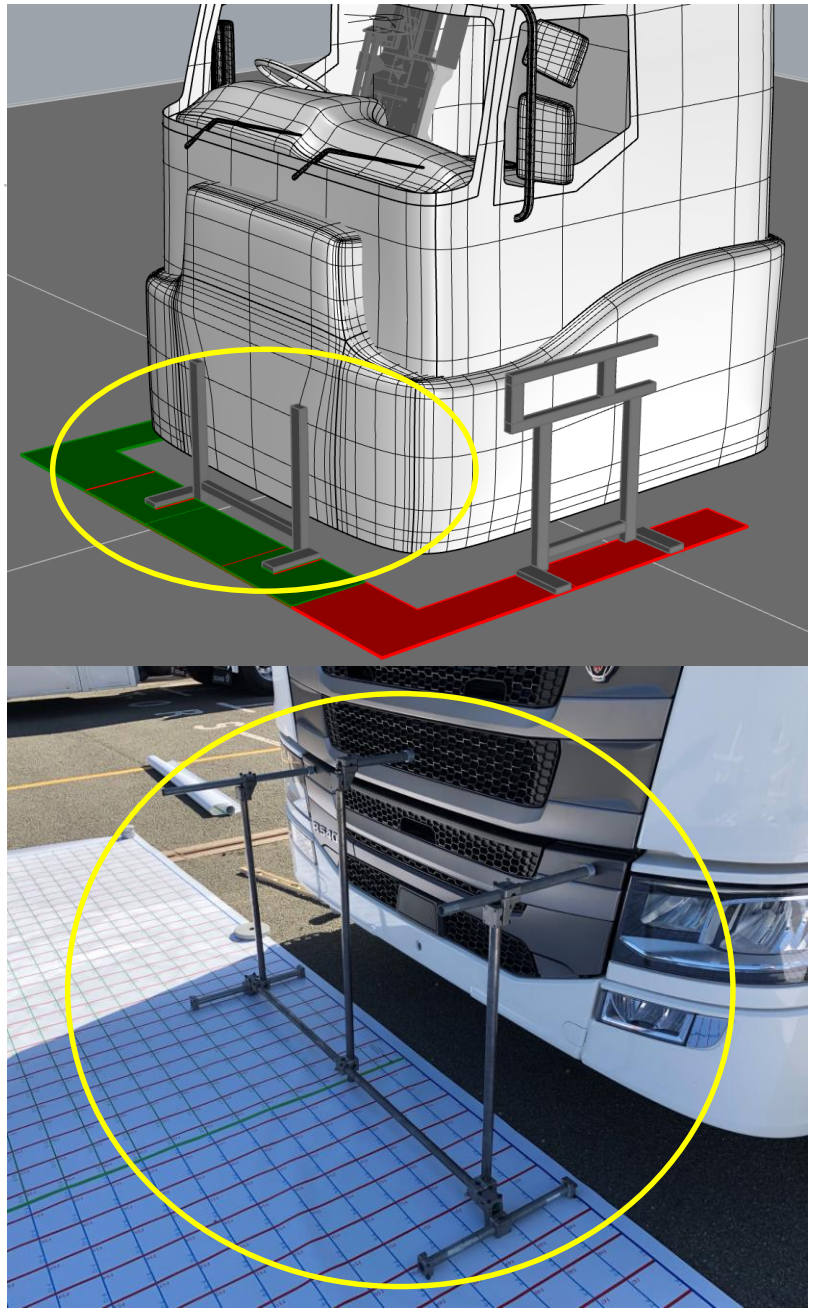
Background – Assessment matts

- A set of three assessment mats have been designed and printed to enable the correct movement of the assessment pole.
- These have been printed as large banners. The material properties are ideal.
- The mats allow white board pens to be used to mark locations and are easily wipeable
- The mats produce a 100mm grid



Background – Alignment structures

- Alignment structures are used to ensure that the mats are aligned correctly to the front and sides of the truck.
- An assessment area of 9m x 9m is required, with a flat floor.
- The first pilot was conducted outside and this highlighted that an interior space is required due to wind moving the mats (and the excessive sun burn suffered by the experimenters)



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Background – Collecting the data –video from second pilot

- We have previously demonstrated that the correlation between the simulated physical testing results and the volumetric testing results stay strong even if we use a 300mm line spacing instead of the initial 100mm line spacing
- However, the pilot testing has been performed by collecting data every 100mm.
- The time lapse video shown here shows all of the data collection over a **four-hour period**.
- The data was gathered using a pole and tape measure
- We are now exploring using laser distance measurement technology to improve the time frame involved in gathering data before testing at Millbrook with type approval technicians
- We think that the measurement time can be **halved**

Time lapse video

Background – Collecting the data –video from second pilot

- The table shows example data gathered during the pilot testing of the Volvo FM (with FMX mirrors)
- The data for the visible sections and occluded sections is gathered using the grid system printed on the mats
- This enables the data to be plotted and compared to the simulated data produced previously

Mat Line	segment 1	occluded	segment 2	
-21				
-20				
-19				
-18				
-17				
-16	361			
-15	606			
-14	896			
-13		247	878	
-12		522	833	
-11		764	716	
-10		989	700	
-9		1232	641	
-8		1536	504	
-7	362	1448	438	
-6	745	1331	454	
-5	1072			
-4	1442	728	547	
-3	1825	207	620	
-2	2616			
-1	2585			
1	2518			
2	2450			
3	2427			
4	2351			
5	2266			
6	2222			
7	2184			
8	2132			
9	2078			
10	2002			
11	1970			
12	1757			
13	768			
Total	39635		6331	45966

Pilots conducted to date

- Pilot testing has been performed with the following vehicles
- Volvo FM for which we have a CAD data
- Scania R for which we have 3D scanned data

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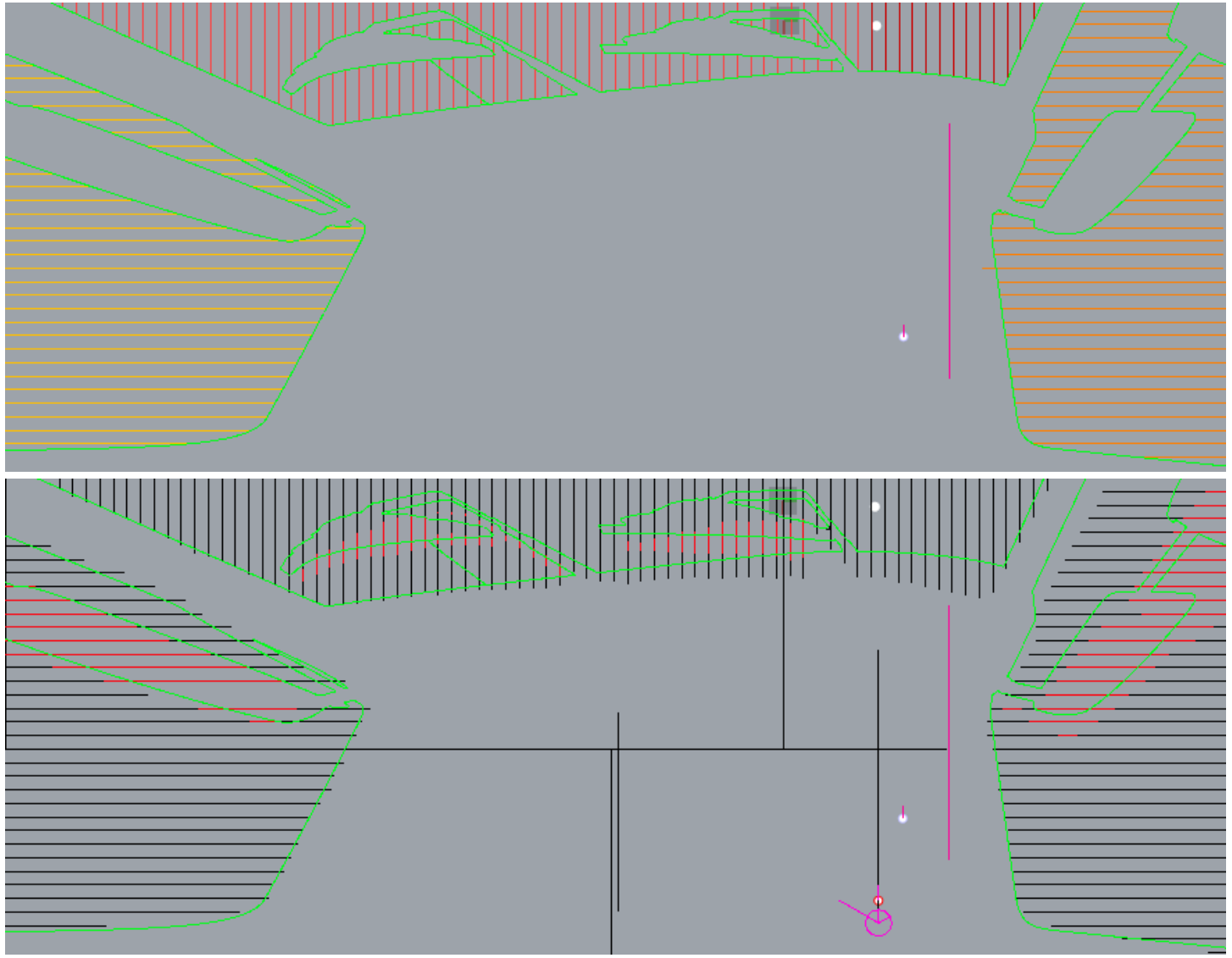
Results for the VOLVO FM Pilot testing

Results for the Volvo FM version 1

- CAD based simulation of the physical testing for the VOLVO FM

- Physical testing results plotted in CAD system

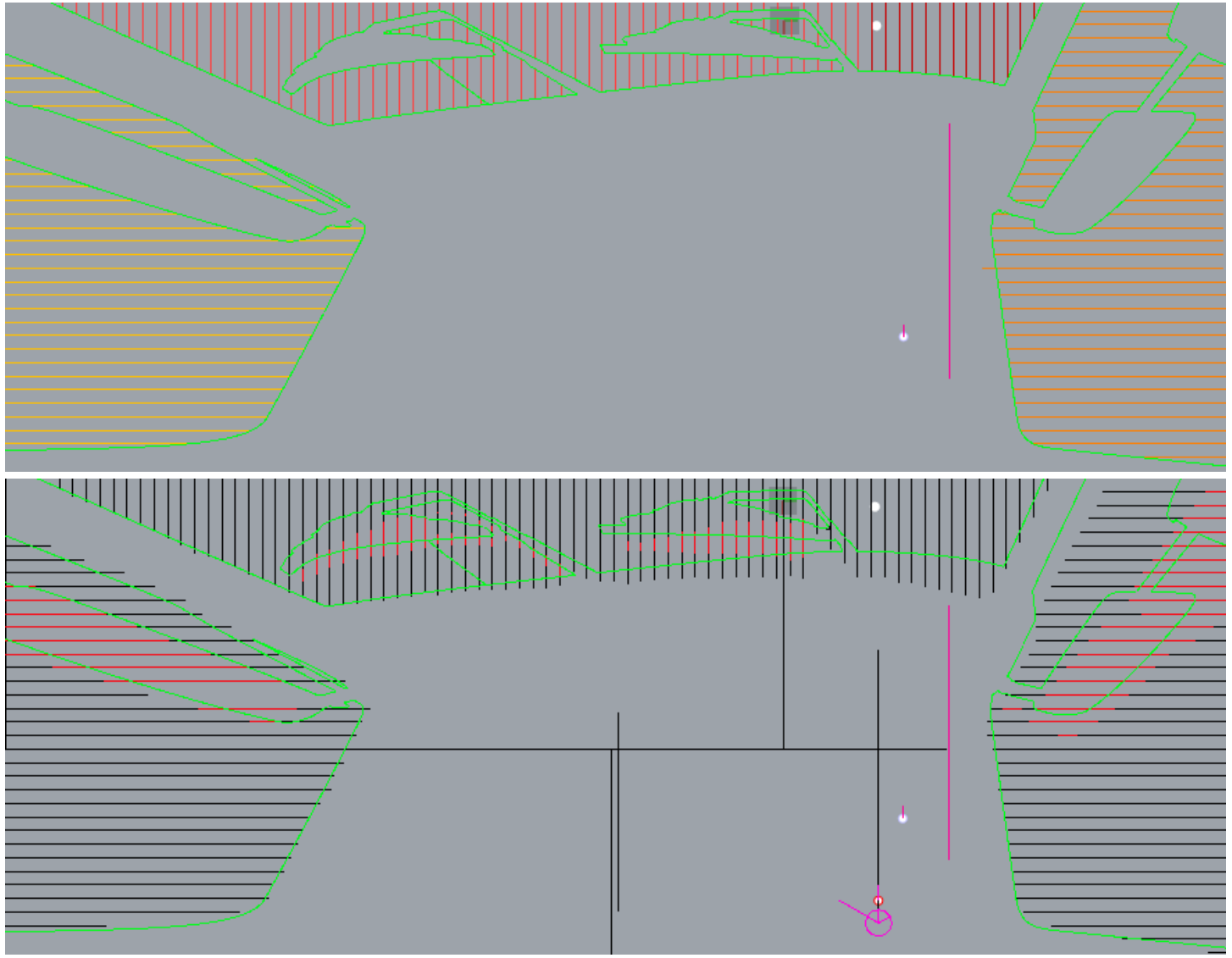


Results for the Volvo FM version 1

- The table shows that there is 4.2% difference between the lengths found using the simulated and real world results

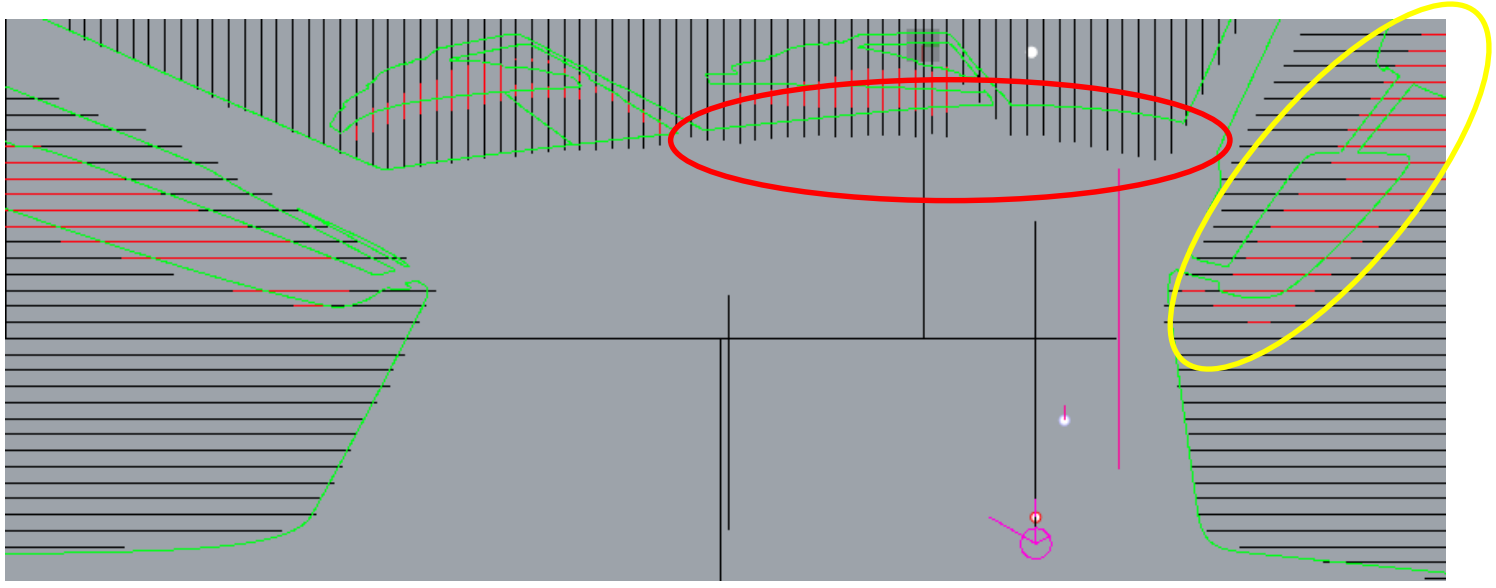
	Pass side	Front	Driver side	Total
Real	45966.00	45460.00	41014.00	132440.00
CAD	46153.20	38306.76	42512.26	126972.23
% Dif	0.41	17.08	3.59	4.22

- This level of accuracy is promising, however there are some issues which can be improved



Results for the Volvo FM version 1

- Issue 1
  - The mismatch between the bottom windscreen line (see red ellipse).
  - This is partially accounted for in that the real truck **leans by 0.63 degrees** with the driver's side being lower
- Issue 2
  - The mismatch between wiper locations
  - The wipers in the real vehicle were set to the off position but there is mismatch in the location compared to the CAD data
  - The obscuration of the wipers is currently underestimated in the real world test
- Issue 3
  - The real world driver's side class II and IV mirrors were in a different location compared to the CAD data (see yellow ellipse)
  - Please note the Volvo FM that was assessed had been fitted with FMX mirrors that are mounted on an arm that can be rotated



Results for the Volvo FM version 1

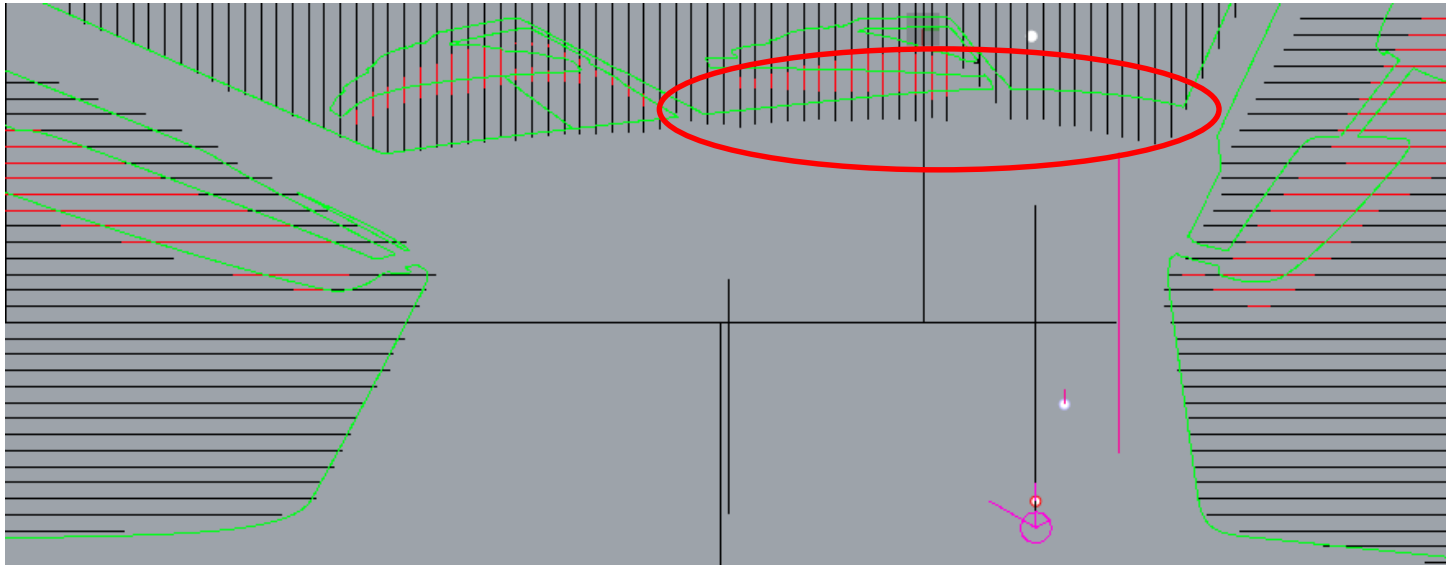
- Further analysis is required
- There was a 0.63 degree tilt in the real world cab which is not accounted for in the CAD

Flat cab

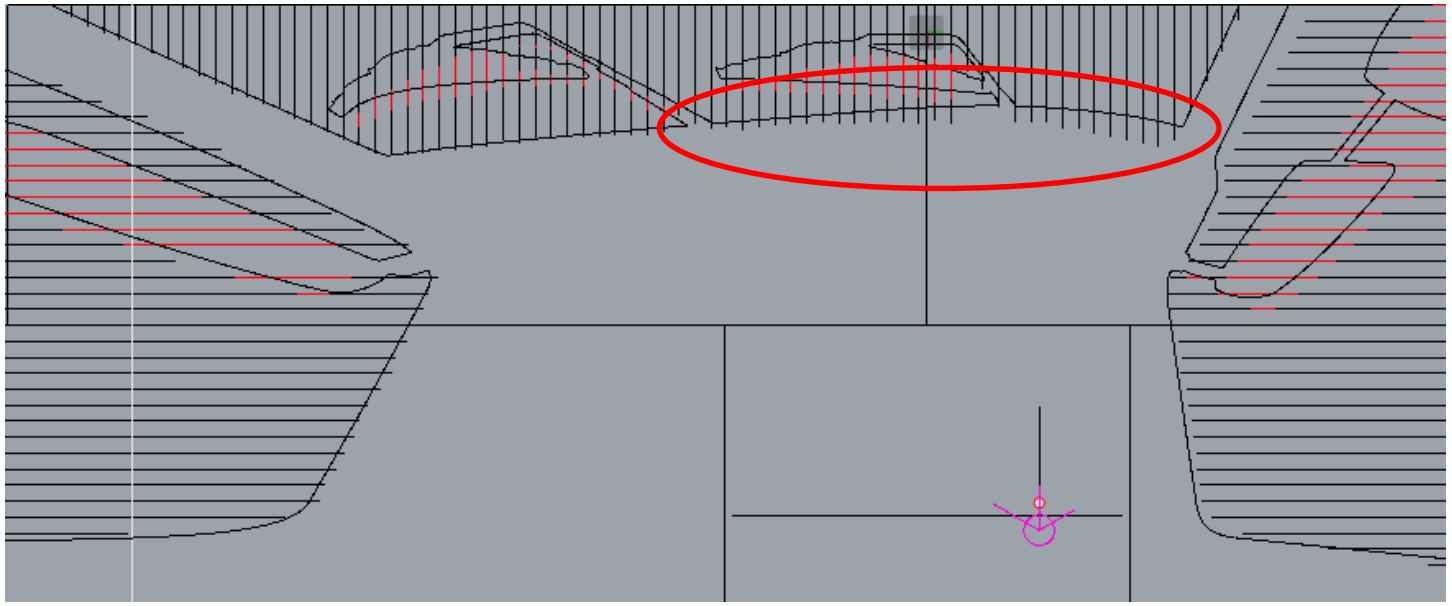
Tilted cab (0.63 degrees)

Comparison between flat and tilted cabs

- Physical testing result plotted in the CAD system for the **flat cab**



- Physical testing result plotted in the CAD system for the **tilted cab**

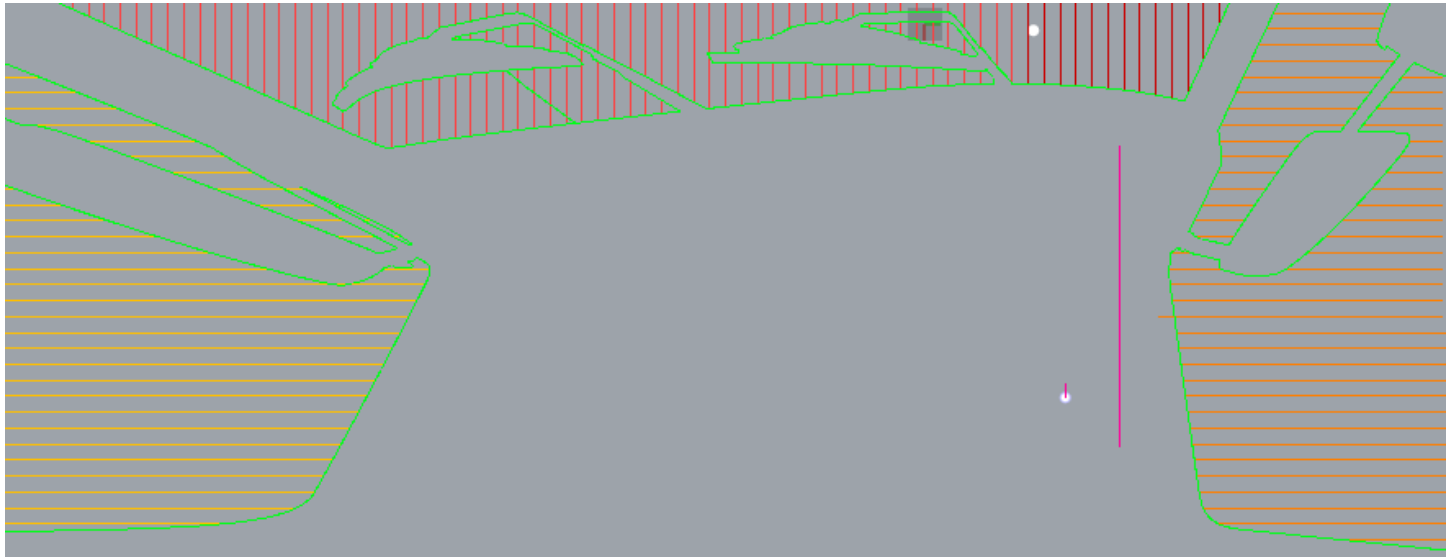


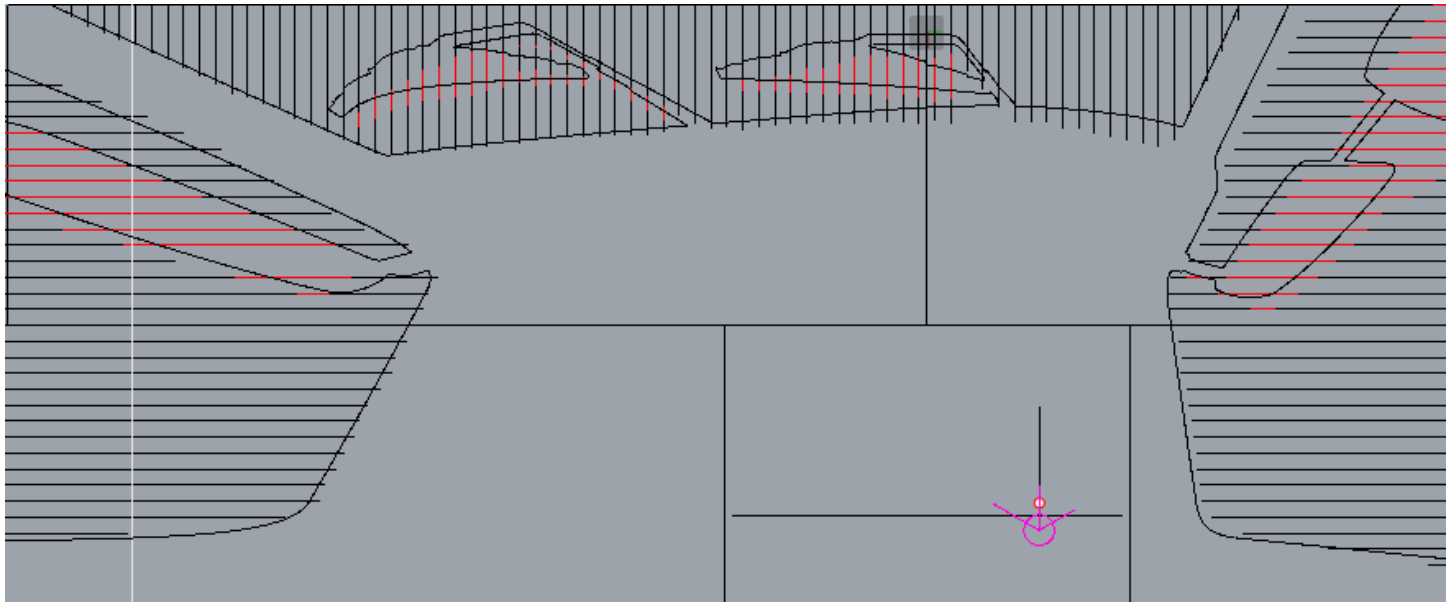
- The alignment to the simulated approach is improved by tilting the cab to reflect the real world

Results for the Volvo FM version 2 – Tilted cab

- The table shows that there is 2% difference between the lengths found using the simulated and real world tilted results when the CAD cab is tilted to the same angle as the real world cab

	Pass side	Front	Driver side	Total
Real	45966.00	45460.00	41014.00	132440.00
CAD	46202.36	41079.85	42477.94	129760.15
% diff	0.51	10.12	3.51	2.04





Results for the SCANIA R Pilot testing

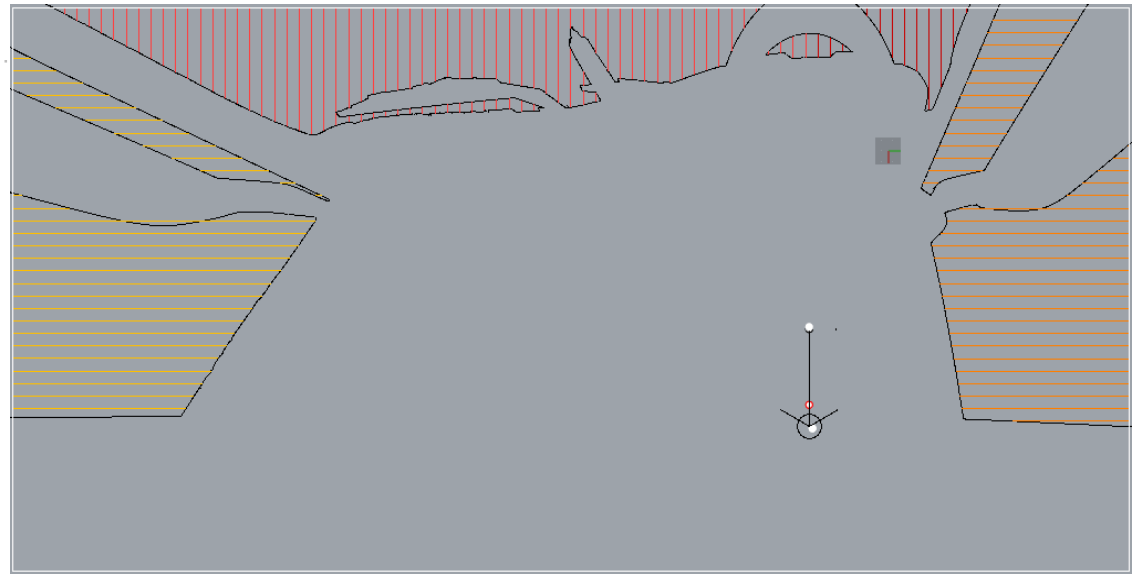
Scania R digital simulation of the Physical test

- Please note, the digital simulation of the physical test that is used to determine the quality of the physical testing results was performed using 3D scan data for the new Scania range

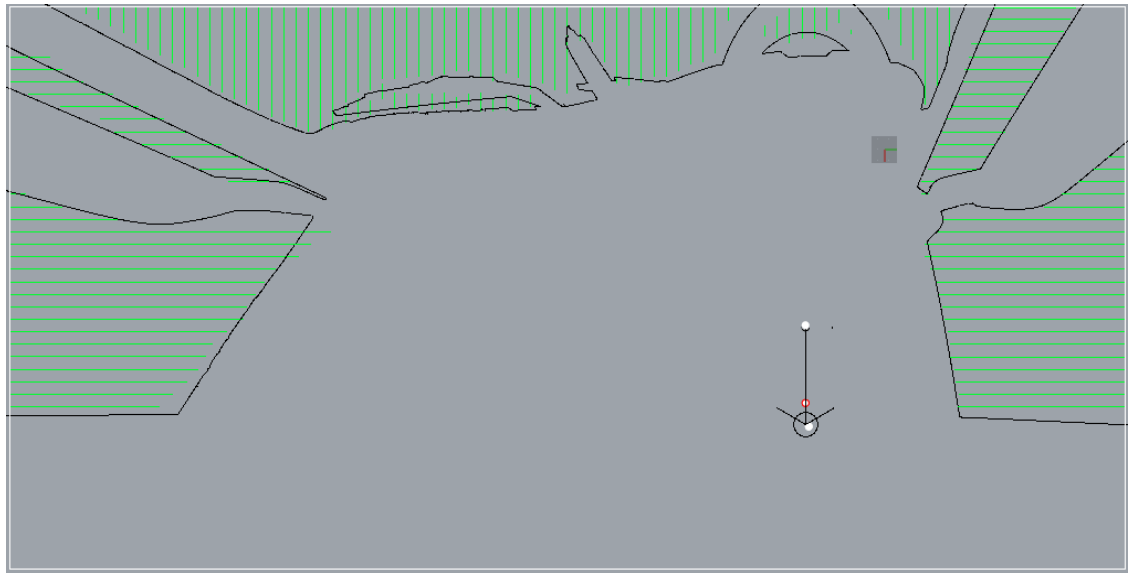
- This removes the issue of the differences in cab angle between manufacturers CAD data and a real world truck, as a real world truck was scanned

Results for the Scania R

- CAD based simulation of the physical testing for the Scania R



- Physical testing results plotted in CAD system

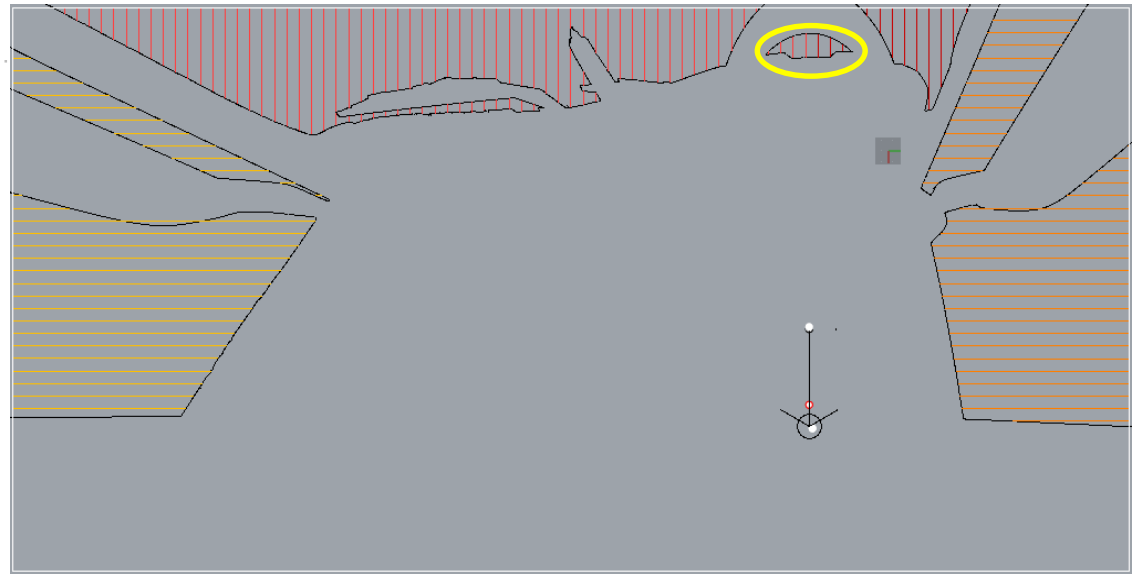


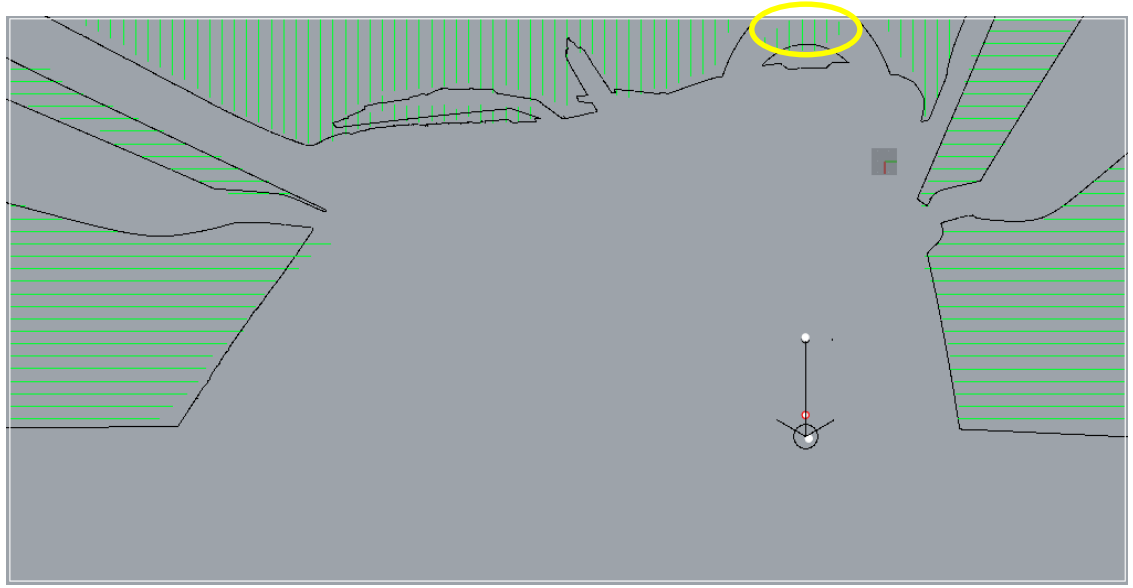
Results for the Scania R

- The table shows that is 4.57% difference between the real and simulated physical testing.

	Pass side	Front	Driver side	Total
Real	37749.2	32788	34029	104566.2
CAD	36790.6	38051.71	34617.9	109460.205
% Dif	2.6	14.8	1.7	4.57

- The % difference for the front is again higher. This is attributed to the **difference in steering wheel position** between the tests which should have been corrected for.



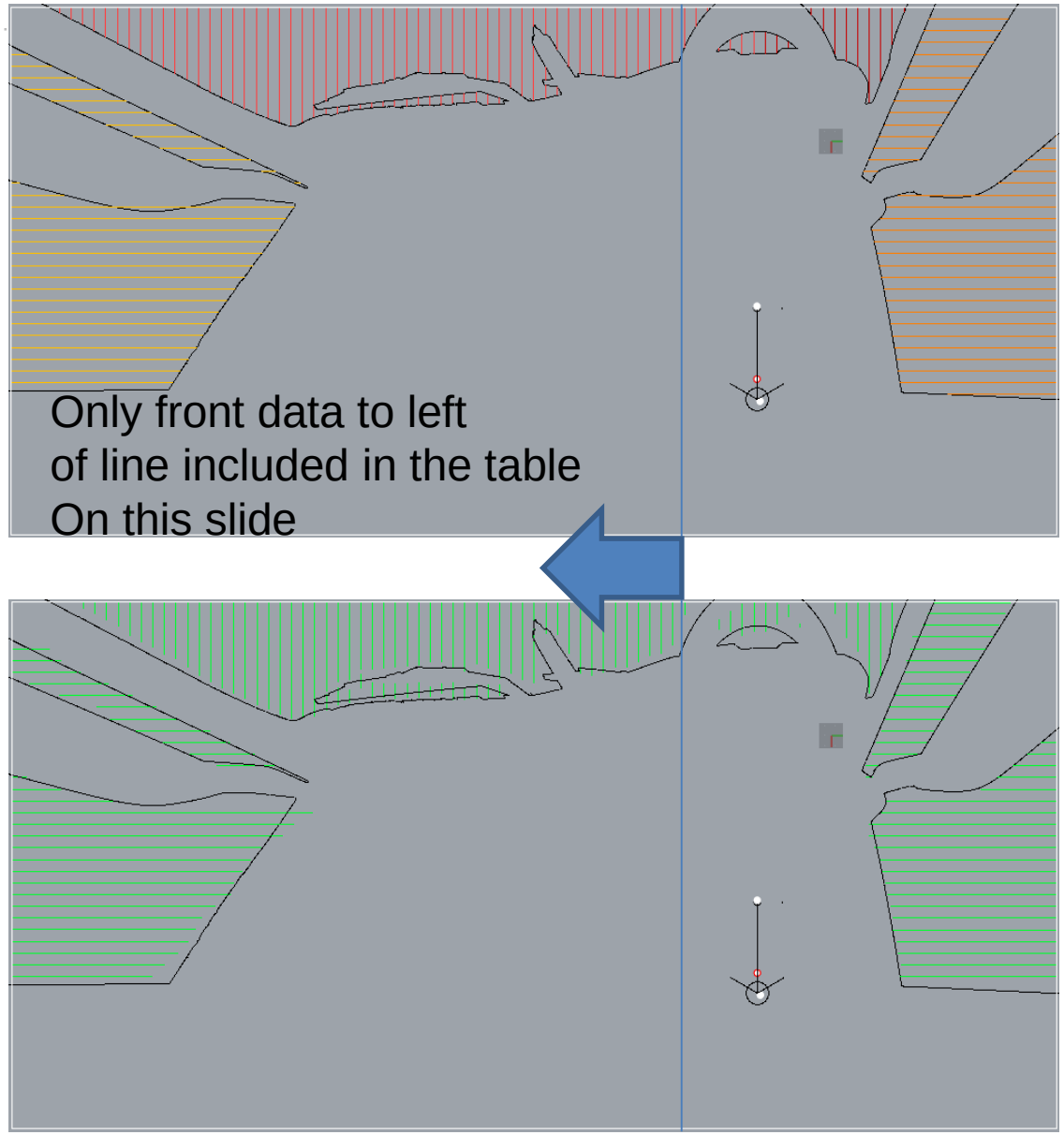


Results for the Scania R

- If we exclude the steering wheel data for the front view the overall % difference improves as per the table below, to 1.16% difference.

	Pass side	Front	Driver side	Total
Real	37749.2	31596	34029	103374.2
CAD	36790.6	33179.7	34617.9	104588.2
% Dif	2.6	4.88	1.7	1.16

- This shows that further pilot testing needs to be in better control of the steering position consistency



Improvements to the physical testing

- The data collection can be improved by using laser measurement technology
  - This will reduce the testing time considerably
- The resolution of the image used on the tablet computer can be improved with better quality cameras to improve the accuracy of data collection for areas such as wiper obscuration
- The rig that simulated the neck height of the Italian female can be improved by adding a light source at the top, and contrast panel behind
  - This should improve the accuracy of tasks such as measuring obscuration by wipers

Next steps

- The suggested improvements will be tested in further pilot testing where possible
- The technique will then be tried by Millbrook proving ground technical staff during October of 2020 to test repeatability of the results

Summary

- The physical testing method pilot has been shown to be largely effective with a difference between results that are simulated in CAD and the real world testing of;
  - **2.1% for the Volvo FM**
  - **1.16% for the Scania R**
- It is anticipated that this % difference can be reduced by improving accuracy of the data collection methods
- The fact that cabs lean or tilt in the real world needs to be accounted for and this will be tested further
- The 4 hour duration of testing can be hopefully reduced by using laser based measurement techniques instead of a manual tape measure

Project information

Thank you for your attention, are there any questions?

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