

V O L V O

LIDAR CONTAMINATION



27-28
F E B.
2023
FRANKFURT

DVN
Lidar

DEEP DIVE EVENT: LIDAR
CONTAMINATION AND CLEANING
LIDAR PERFORMANCE
IN BAD WEATHER

V O L V O



sensors on the roof integration - Stakes

1 Foreign Contamination

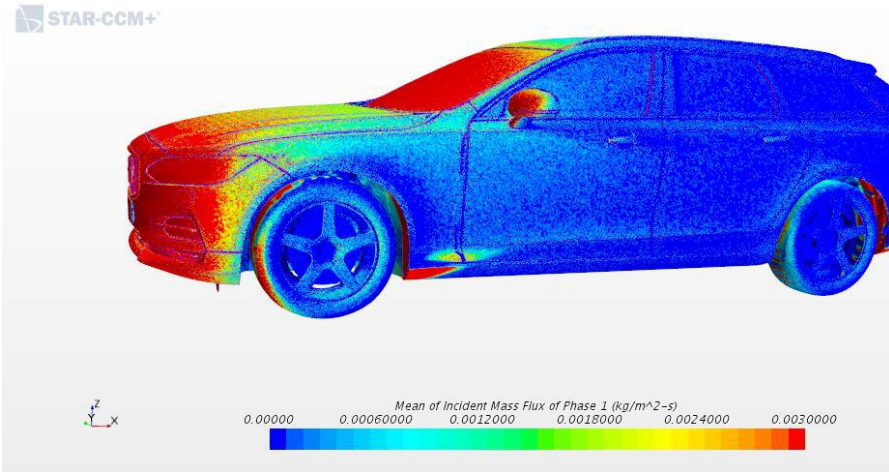
2 Self contamination

3 Aerodynamics

4 Temperature & required cooling system

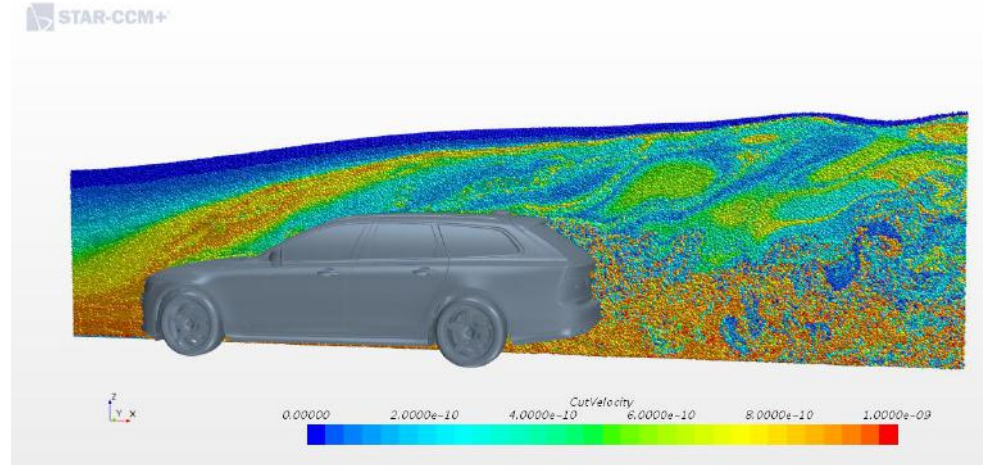
(1) sensors on the roof – Foreign contamination

Importance of the location & simulation



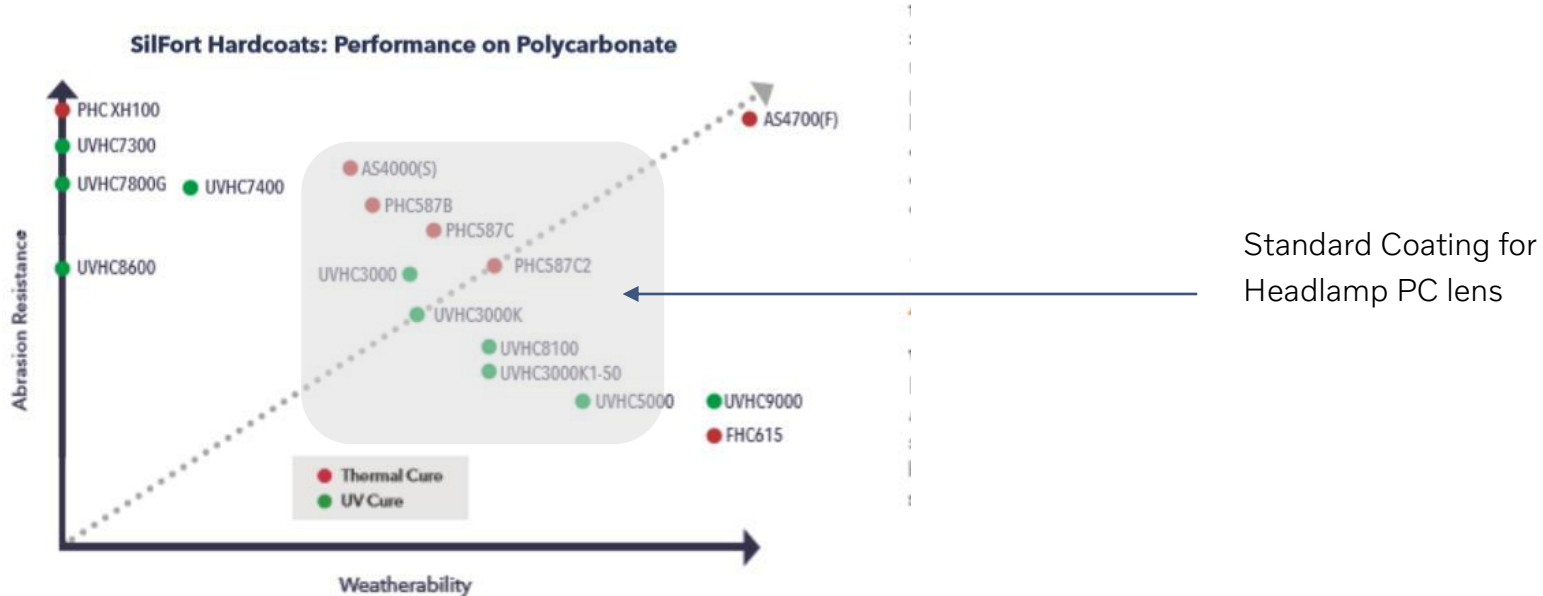
Importance of a good cleaning system

Importance of a good scratch resistance



(1) sensors on the roof – Foreign contamination

Example of PC-lens coating scratch resistance – extract from momentive-silfort-brochure%20(002).pdf



(1) sensors on the roof – Foreign contamination

Cleanability of the surface

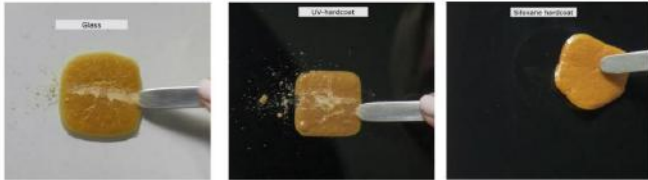
Self-Cleaning Effect of Coated Polycarbonate

Procedure:

- Surface is contaminated with a protein (egg) mixture and baked for 24 h @ 60°C:

Surfaces:

- A. Glass
- B. UVHC5000 on PC
- C. AS4700 on PC



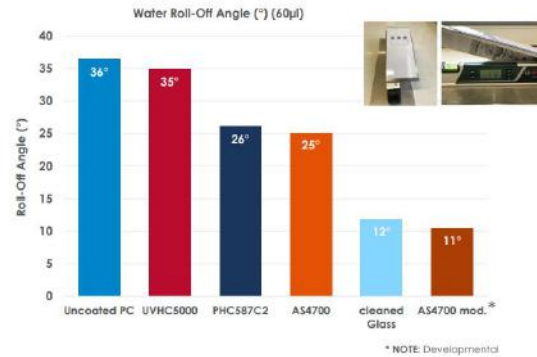
SilFORT Thermal Hardcoats Offer The Highest Self-Cleaning Effect

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Internal test data. Actual results may vary.

MOMENTIVE

Water Roll-Off Angle (Dynamic)



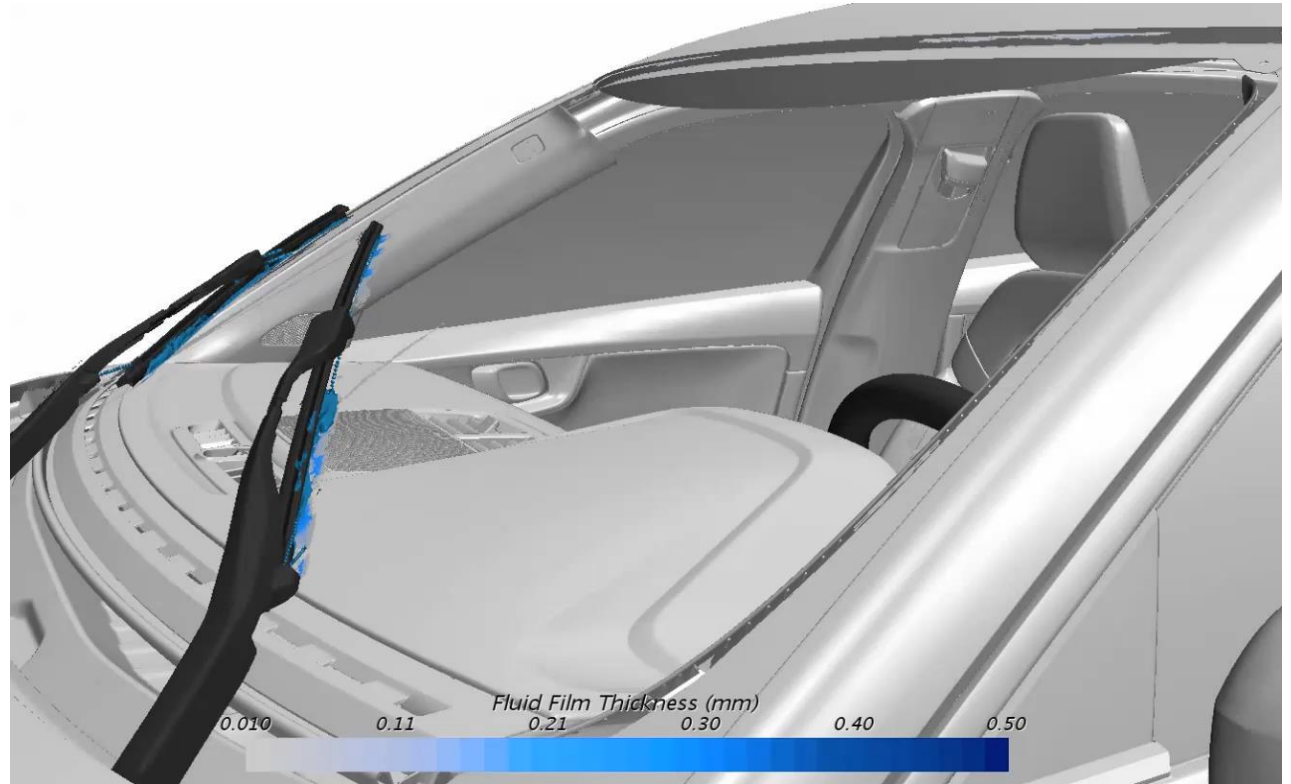
SilFORT Hardcoats Provide A Lower Water Roll-Off Angle and Better Cleanability

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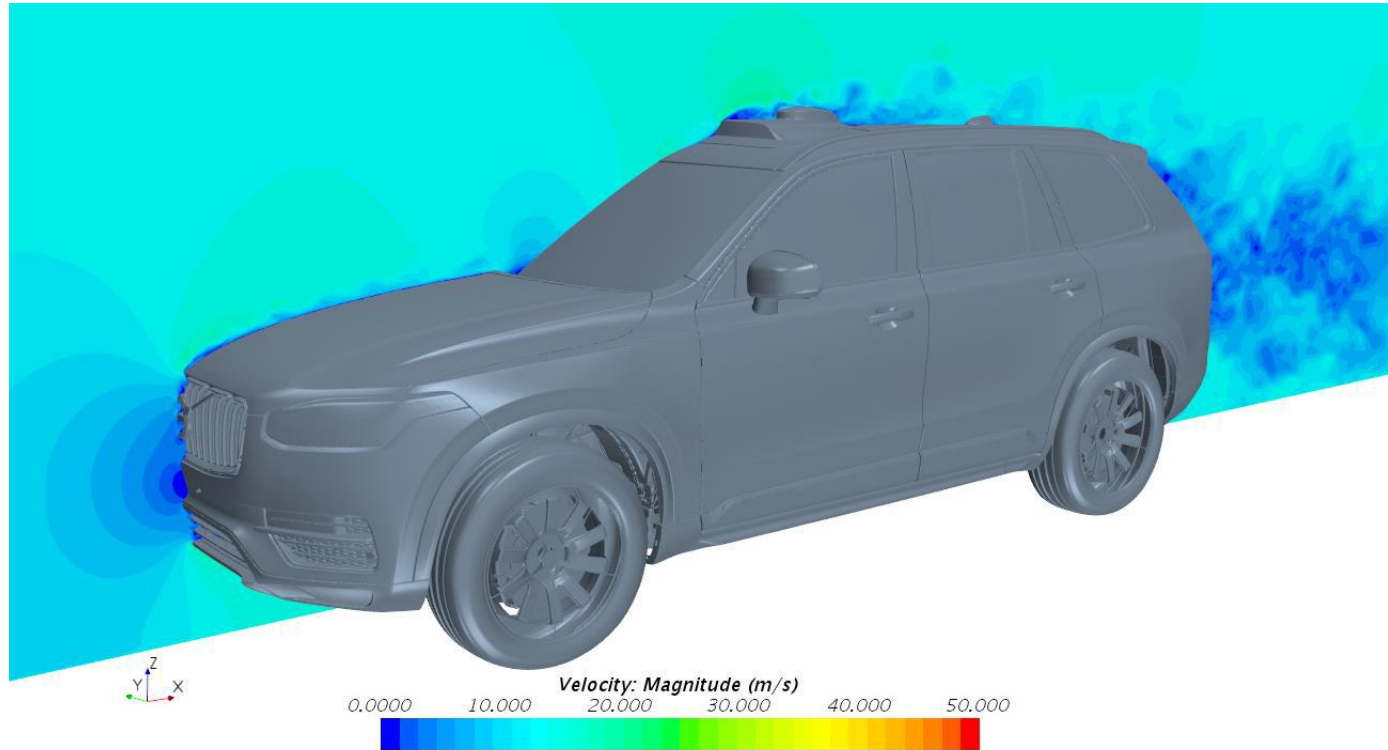
Internal test data. Actual results may vary.

MOMENTIVE

(2) sensors on the roof – Self contamination



(3) sensors on the roof – Aerodynamics impact



(4) Thermal impact and self heating

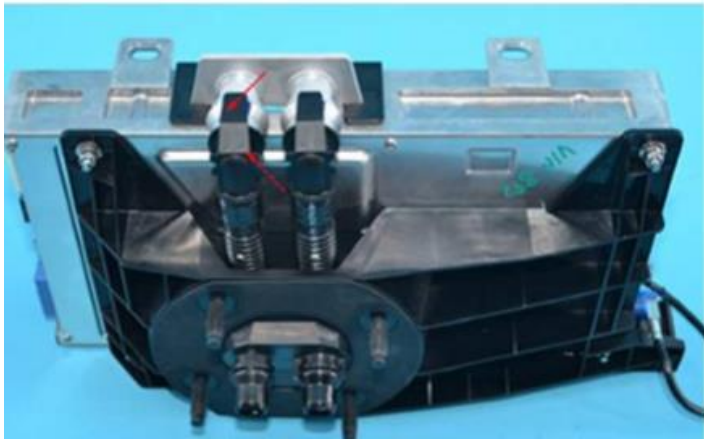
Maximum Ambient temperature

Self heating

Derating in worse condition with / without functionality

Definition of a cooling system

} Thermal simulation



Benchmark of cooling system for ECU



Conclusion

Sensor by itself is important but not enough,

From OEM perspective, sensor integration is a key issue :

- Transmission though outrelens
- Location
- Contamination
- Cleaning
- Scratch resistance
- Thermal load



Toolbox for simulation + Testing

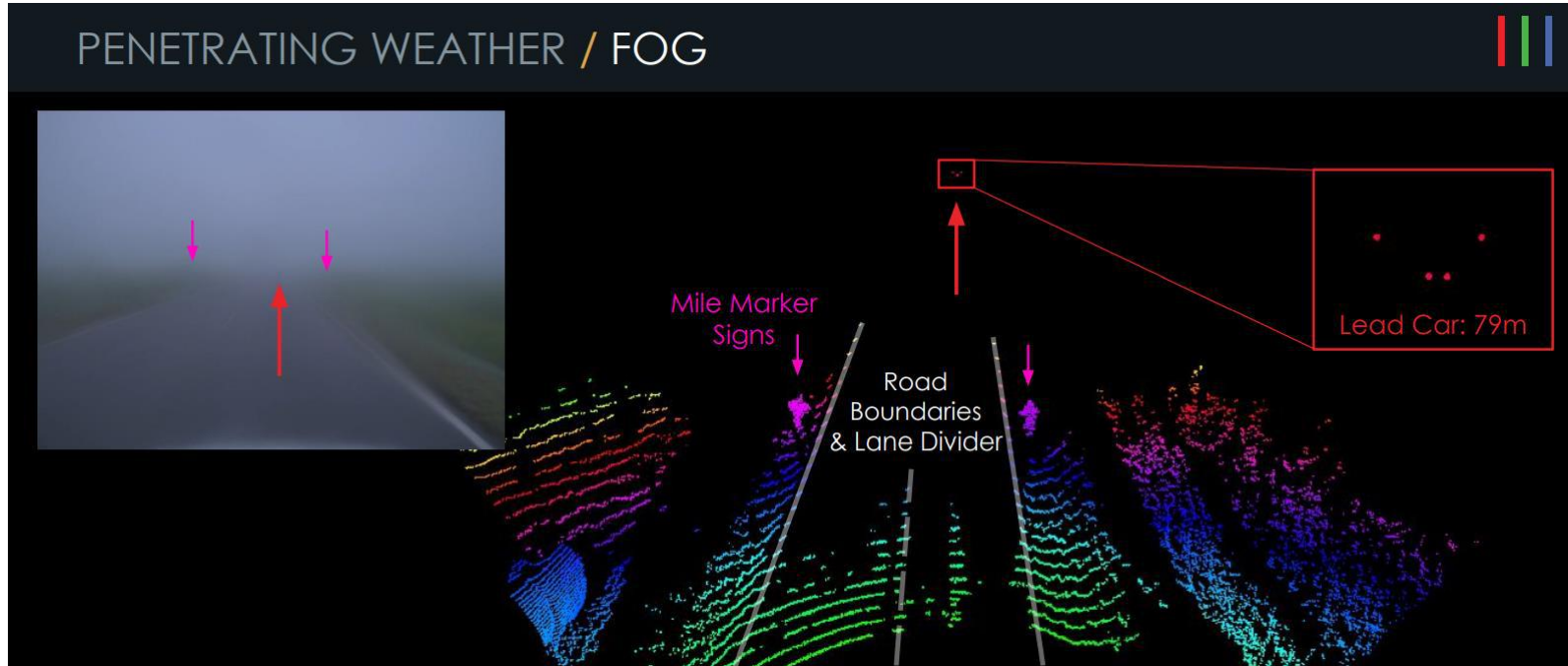
Performance under heavy conditions

Testing under different weather conditions



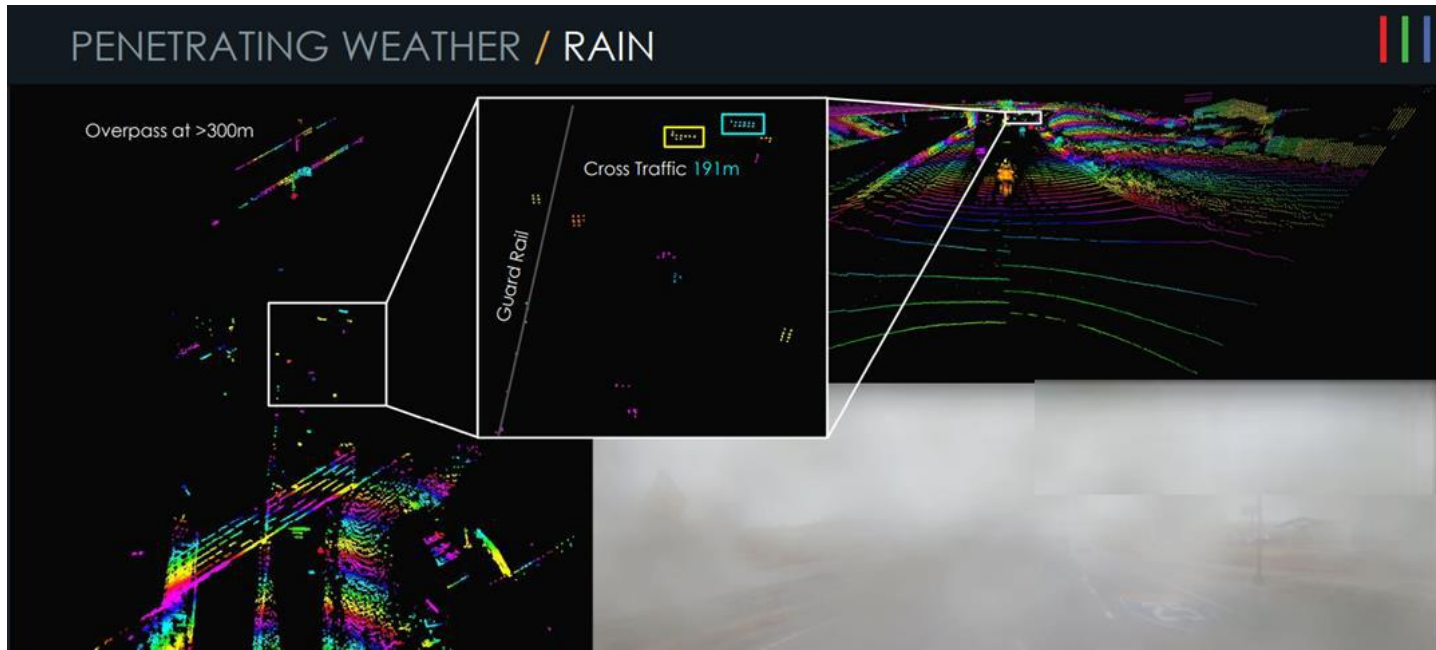
(1) Heavy fog

Heavy fog conditions captured by Luminar lidar and camera at the same time stamp. In these conditions, with no window clearing for either sensor, lidar detection of the lead car is 79m at which time camera data shows nothing discernible.



(2) Heavy rain

Heavy rain conditions captured by Luminar lidar and camera at the same time stamp. In these conditions, lidar detection of the road surface is possible to nearly **40m** depending on the degree of puddling on the road surface. An upcoming cross-traffic intersection is detected at more than **190m** by detecting and tracking vehicles highlighted in yellow and blue boxes within zoom panel

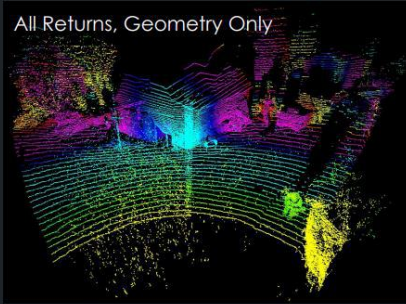


(3) Snow

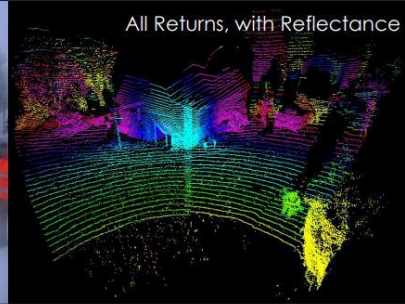
Snow conditions captured by Luminar lidar and camera at the same time stamp. In these conditions, lidar detection of falling snow extends to **20m**. These detections are very low reflectance, and leave no “holes” in the point cloud and so understanding the scene is simple

PENETRATING WEATHER / SNOW

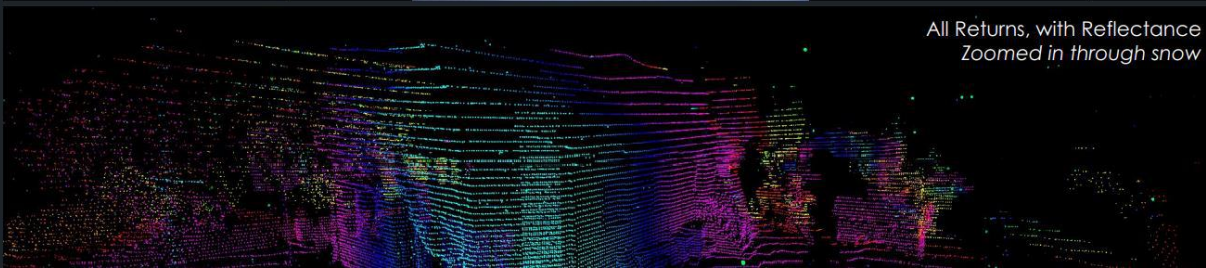
All Returns, Geometry Only



All Returns, with Reflectance



All Returns, with Reflectance
Zoomed in through snow



(4) Test in lab

To reproduce exterior heavy conditions

Location: Rail Tech Arsenal, Vienna, Austria

- 100m tunnel
- Rain: 15 l/h, 50 l/h, 80 l/h
- Wind speeds: 10 km/h, 30 km/h, 60 km/h
- Fog intensities: 5%, 10%, 25%, 100%
- Droplet Size Distribution (DSD) for fog was given



(5) Test procedures

Need to develop standard rule :

- SAE norm in USA ?
- European best practice ? Join GTB working group ?

[Docs – Lighting and Visibility for Sensors \(TF-LVS\) – GTB \(gtb-lighting.org\)](http://gtb-lighting.org)



Lighting and Visibility for Sensors (TF-LVS)

TASK FORCE

A screenshot of a LinkedIn group page for 'Lighting and Visibility for Sensors (TF-LVS)'. The page features the 'LVS' logo in blue, indicating it is a 'Private Group' that was active 14 days ago. It shows options for 'Group Administrators', 'Group Mods', and 'LEAVE GROUP'. A description box states: 'TF dedicated to the assessment of all the aspects of visibility for sensors and dedicated lighting.' At the bottom, there are navigation links for 'Home', 'Docs', 'Members (36)', and 'Email Options'. The 'All Docs' section is highlighted, showing 'Lighting and Visibility for Sensors (TF-LVS)'s Docs'.

