

Exploiting High-Quality Experimental Data for AI at Catesby Tunnel

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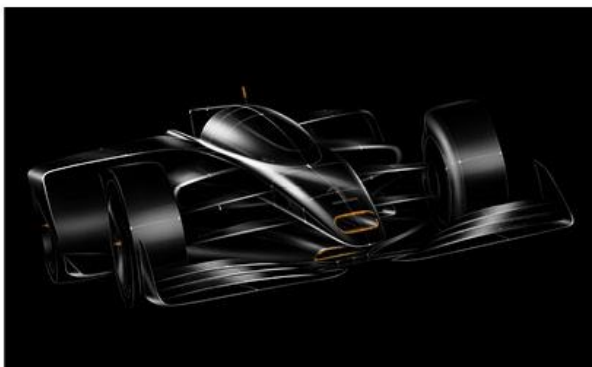
CFD Consultancy



Livery and Graphic Design



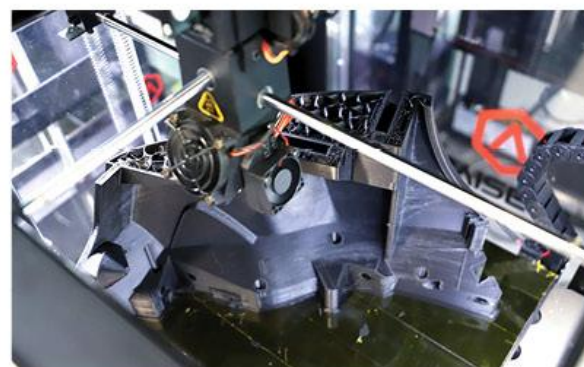
Rendering and Visualisation



Design | Styling



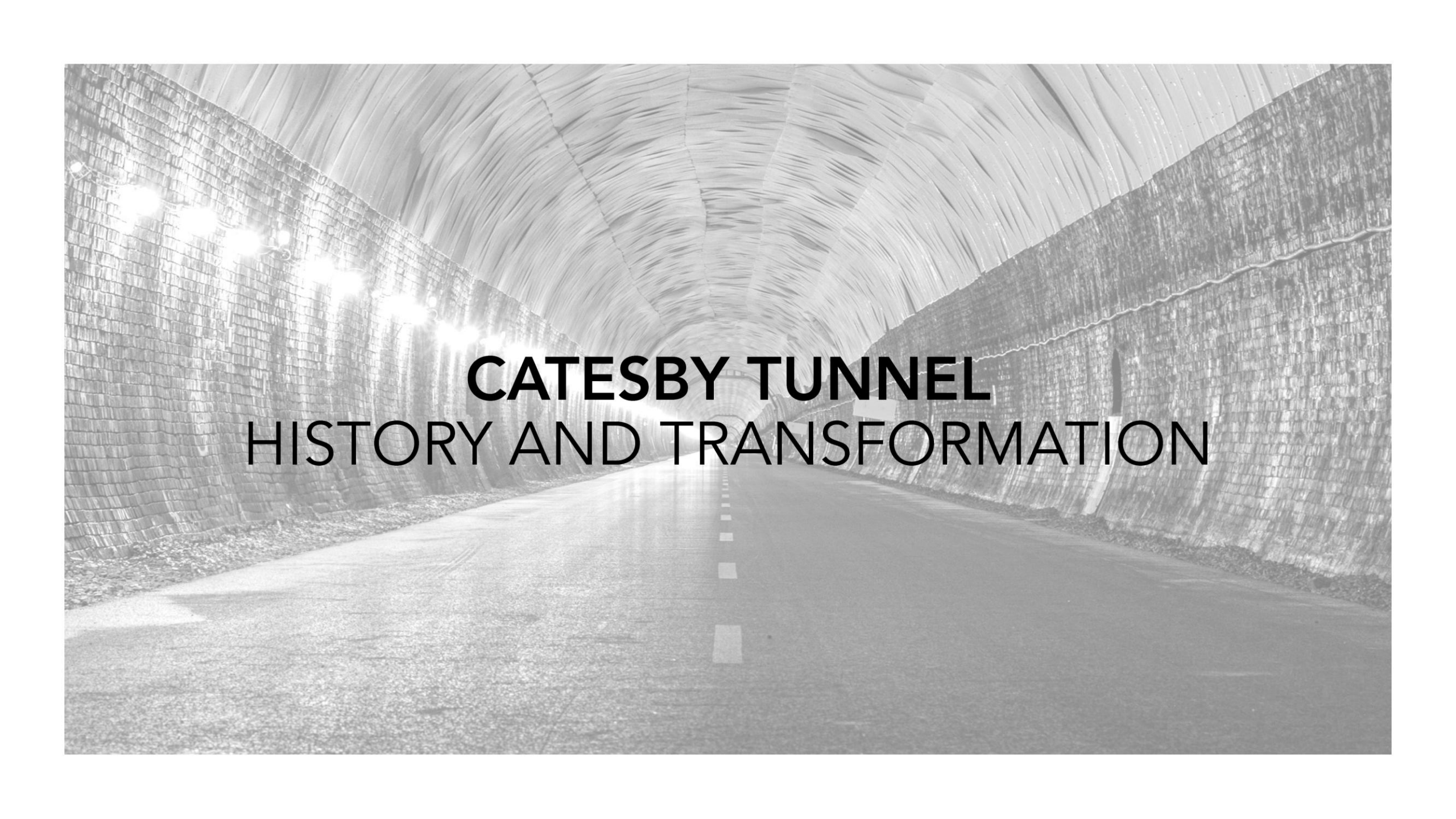
3D Scanning



3D Printing



**Catesby Tunnel Time
and Support**



CATESBY TUNNEL

HISTORY AND TRANSFORMATION



1899 - 1966



2017



2021



2021



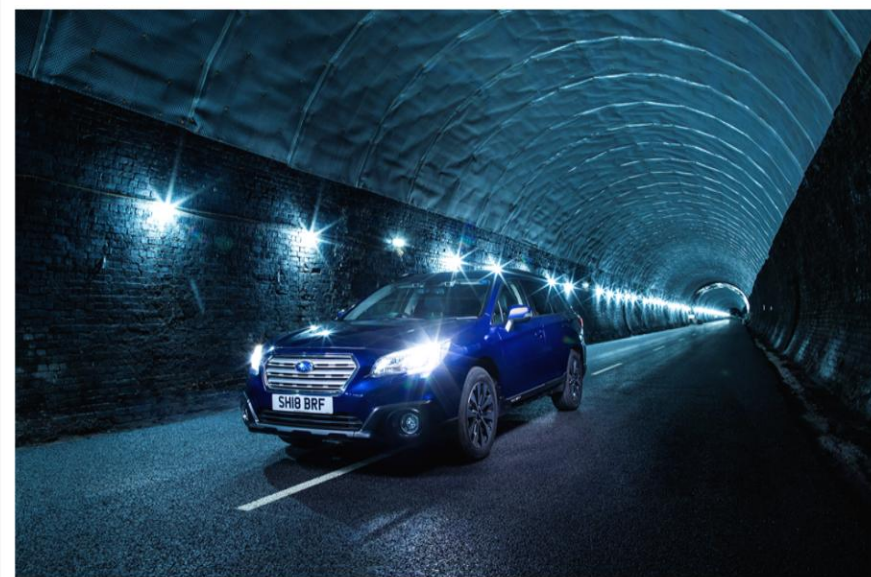
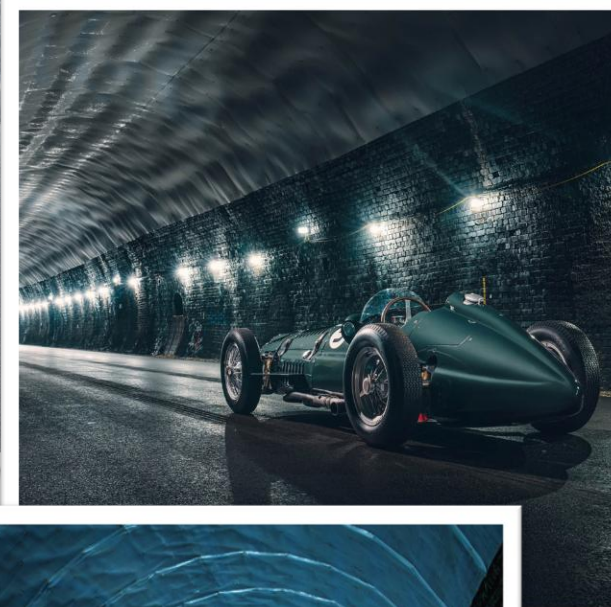
2021

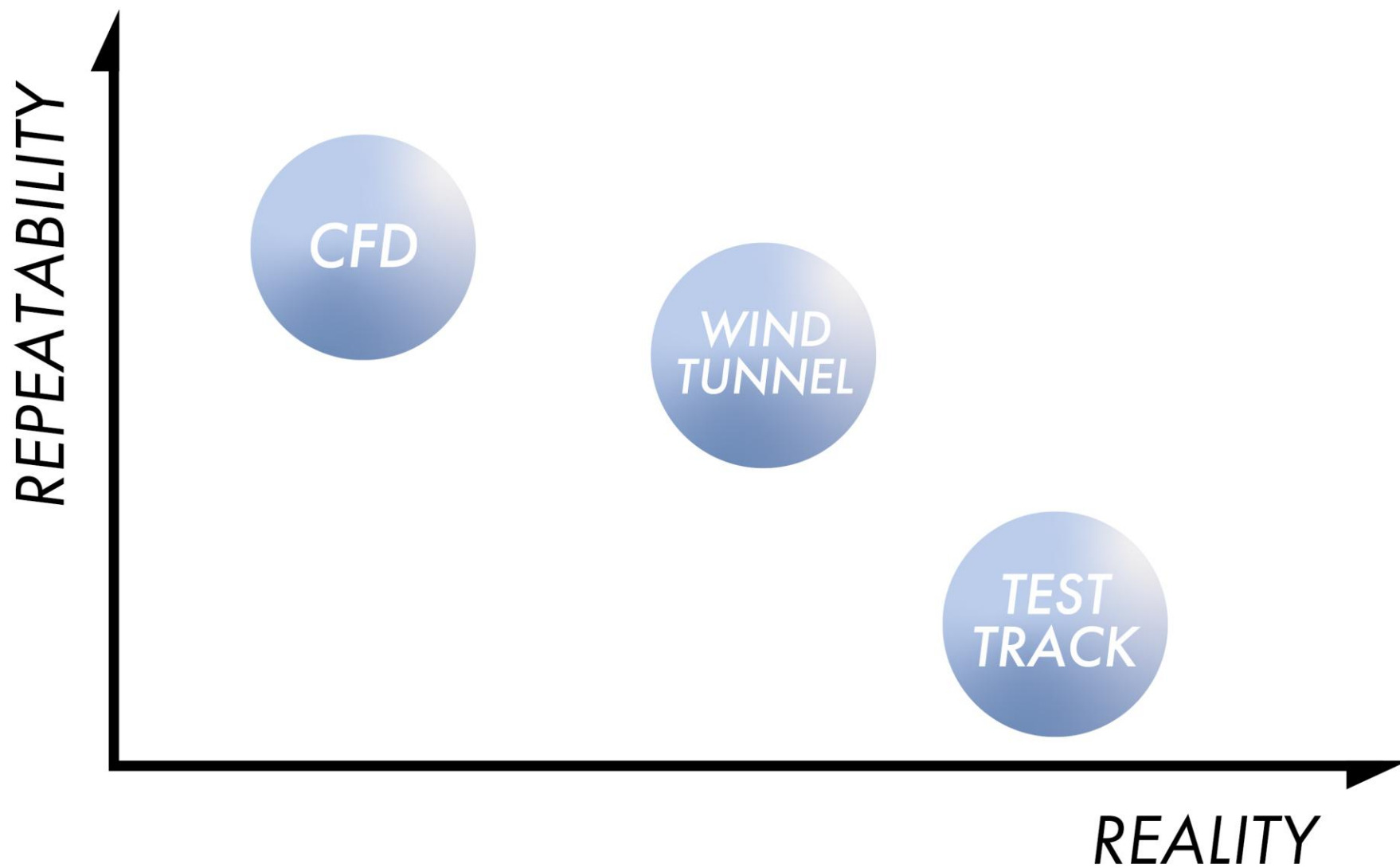
CATESBY TUNNEL

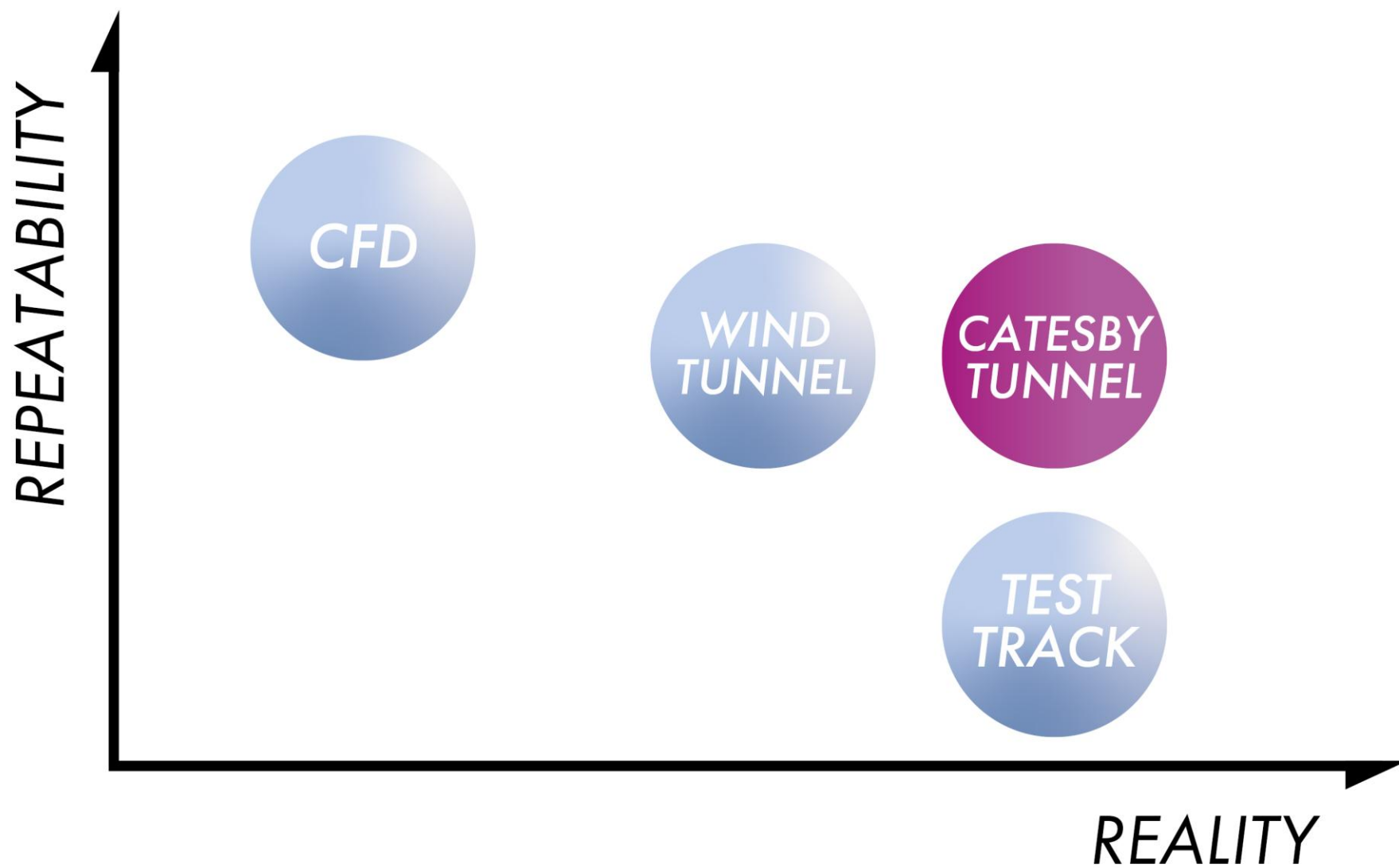
IN NUMBERS



2,700m long
42sqm cross section
1:176 gradient







What has this got to do with AI?

*“AI (artificial intelligence) is technology that enables computers to perform tasks associated with human intelligence—such as understanding language, recognizing patterns, **learning from data**, reasoning, and making decisions.”*

ChatGPT 08/09/2026

What has this got to do with AI?

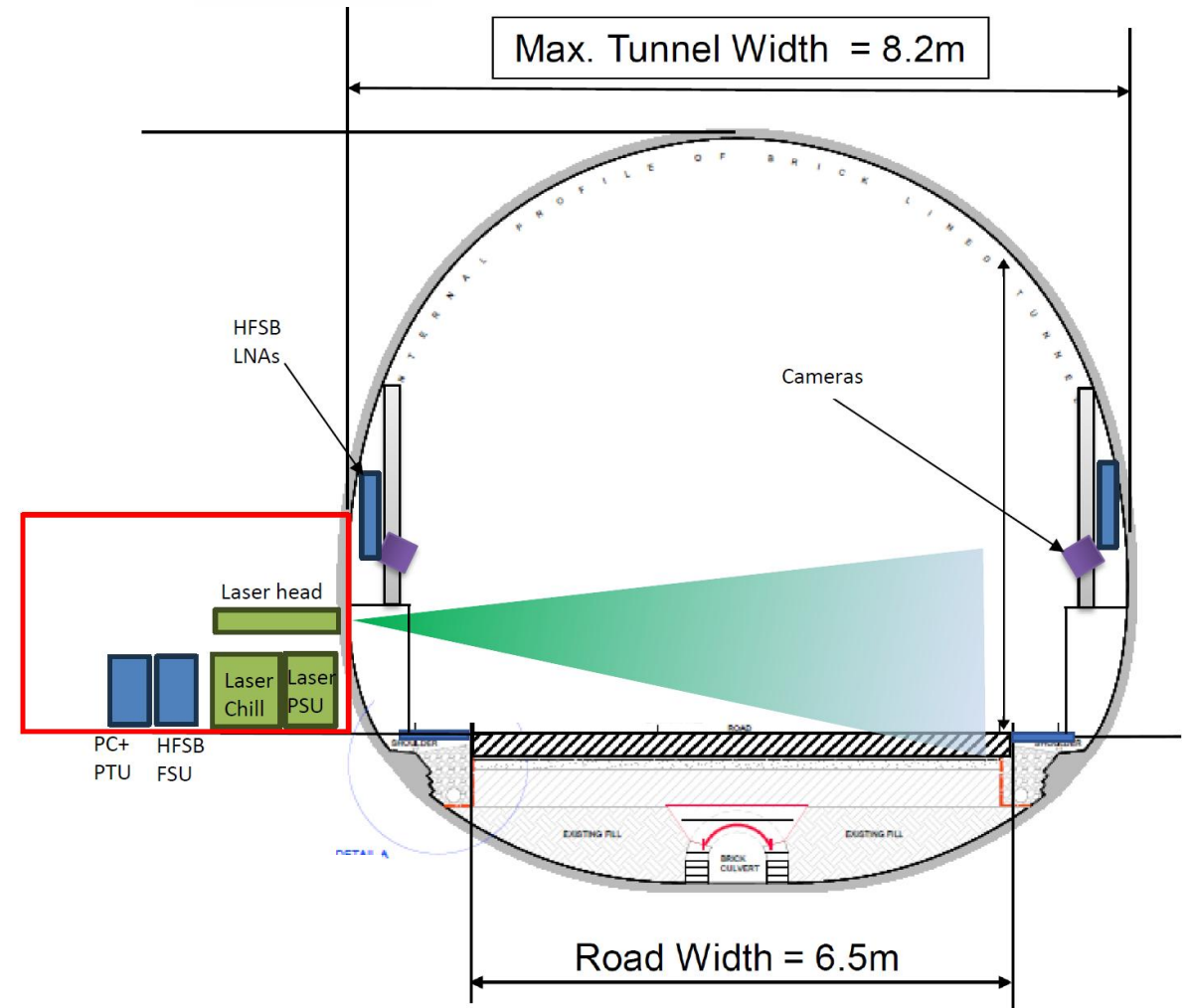
Reliable experimental data is fundamental to reliable AI tools.

Rubbish in > Rubbish out.

PIV

PIV in Catesby

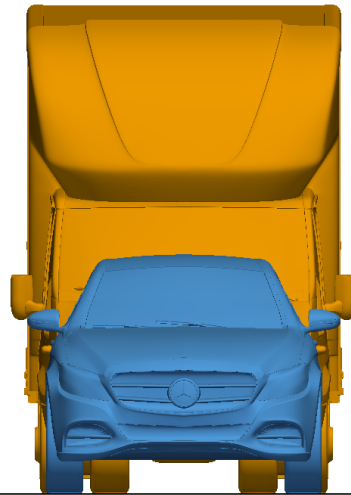
- Vehicle moves through light sheet.
- HFSB from multiple rakes upstream.
- STB 'Shake the box' approach which is LaVision's PTV technique.
- Tracks individual particles.
- 8 cameras to give 3D triangulation with redundancy.





Tunnel walls...

Not ideal... Or opportunity?



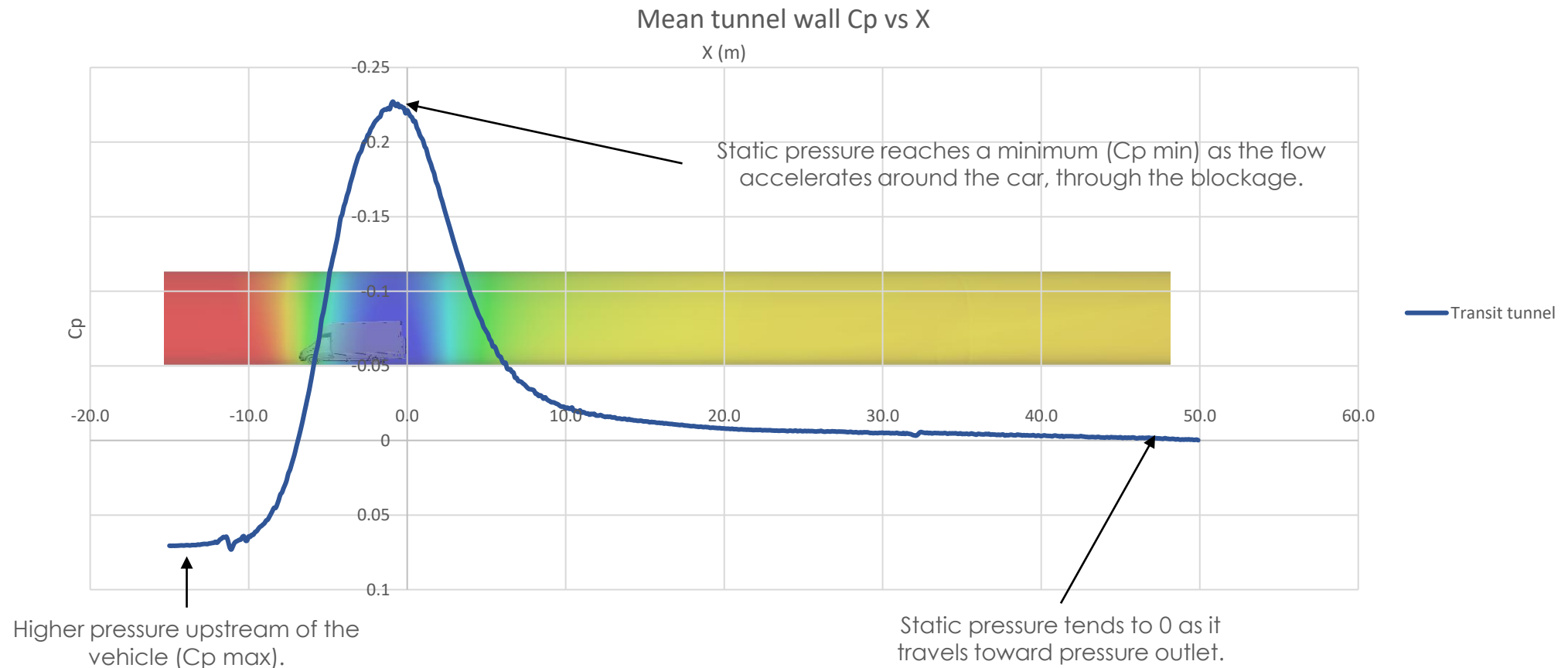
Pressure Profile Opportunities.

Pressure trace could be measured (at a high sampling rate) as the car passes a single ring of pressure tapings installed in the tunnel wall.
Sample pressure slice results from CFD simulations below.



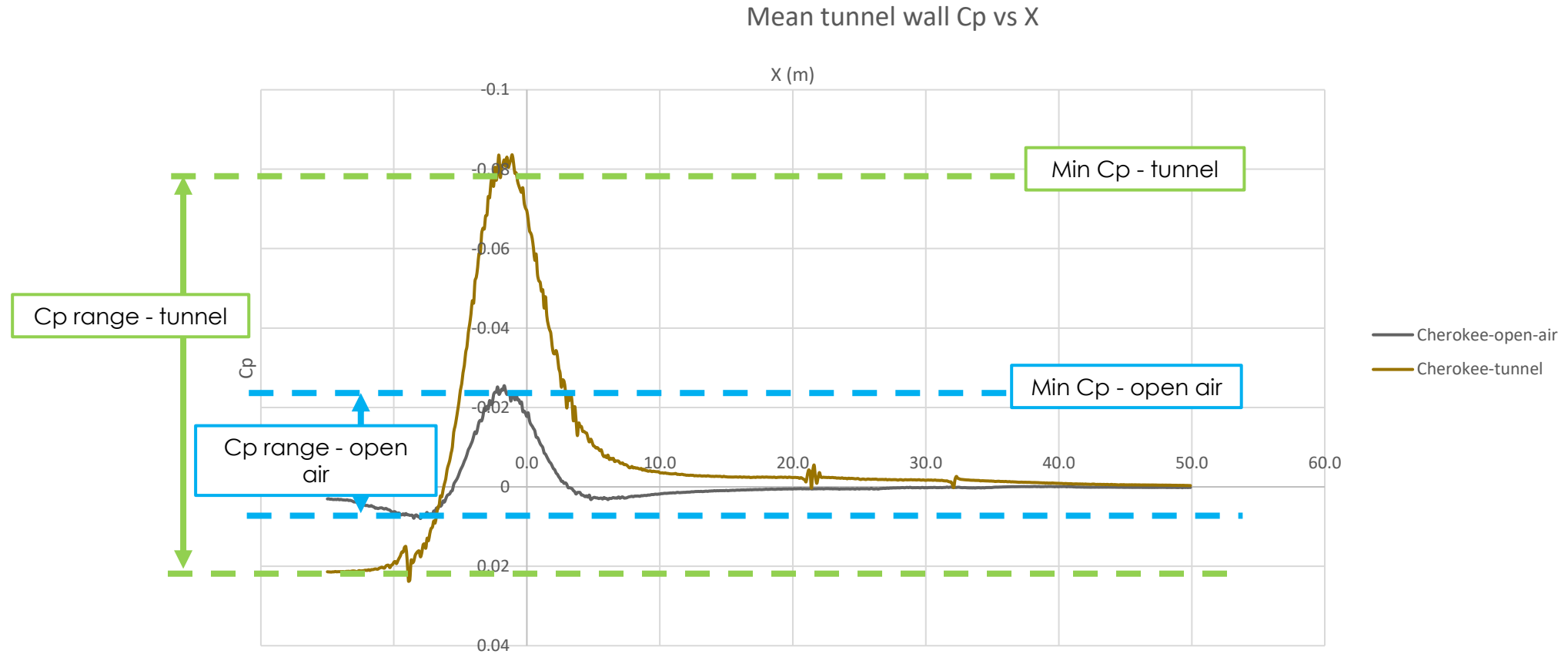
Pressure Profile Opportunities.

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Sample pressure slice results from CFD simulations below.



Blockage Correction?

Comparison of pressure profiles from tunnel walls and equivalent open air.



Blockage Correction...



City (Fiat 500)



Hatch (Fiesta)



Notchback (C-Class)



SUV (Cherokee)



MPV (Caravan)



Convertible (S2000)



Sports (911)



Pickup (F-150)



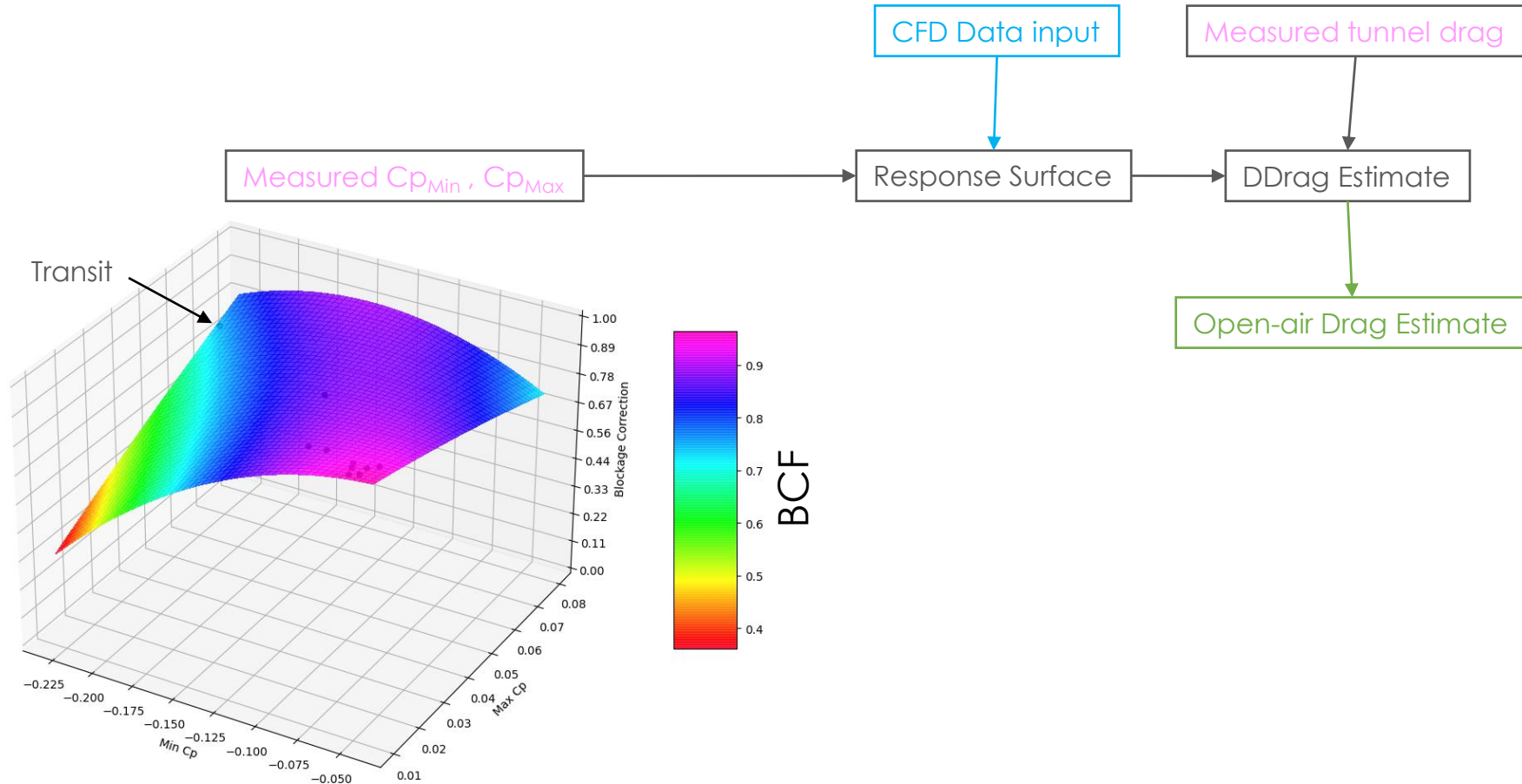
Box van (Transit)

Blockage Corrections

A response surface that relates $C_{p_{min}}$ and $C_{p_{max}}$ to blockage correction ratio has been created from the CFD models.

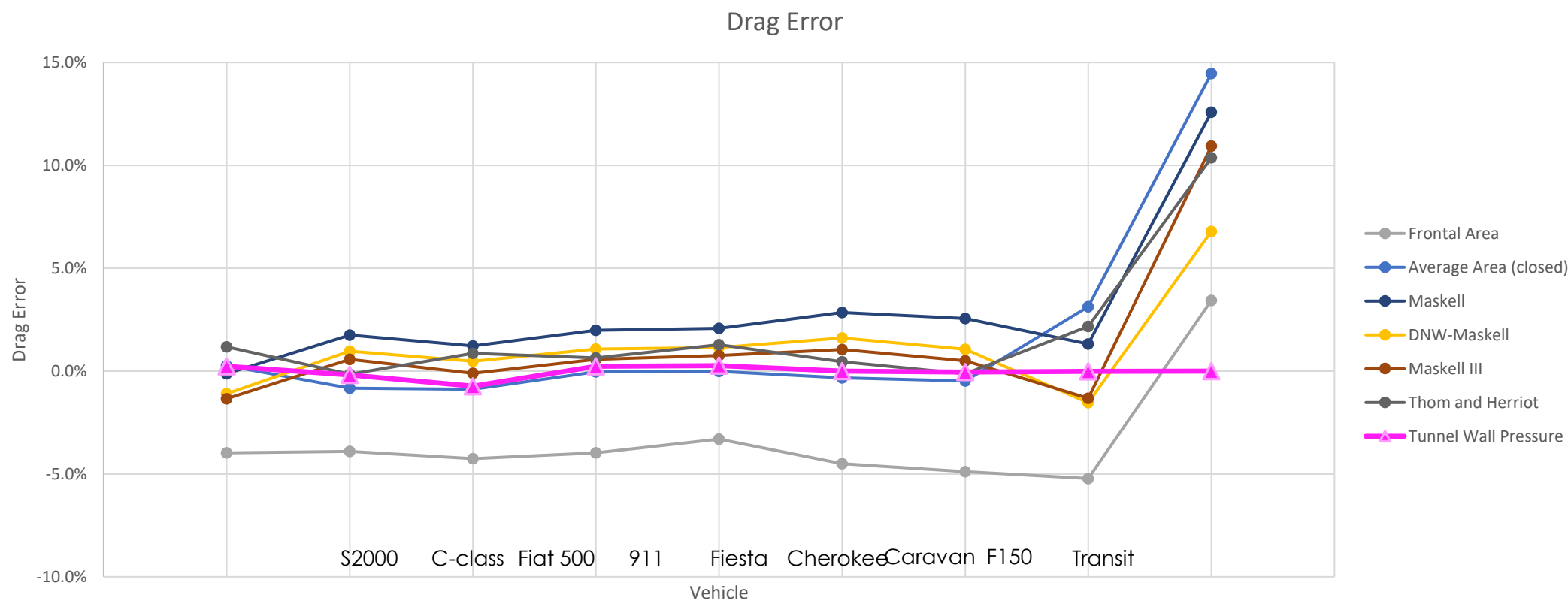
The aim is to “train” the response surface with a large amount of CFD models, so it covers a wide range of vehicle shapes and sizes. The response surface can then undergo “stress tests” to see how well it predicts blockage correction for vehicles of new shapes and sizes.

It is ultimately intended that the response surface can be used for blockage corrections at Catesby tunnel, once enough confidence is built in the model.



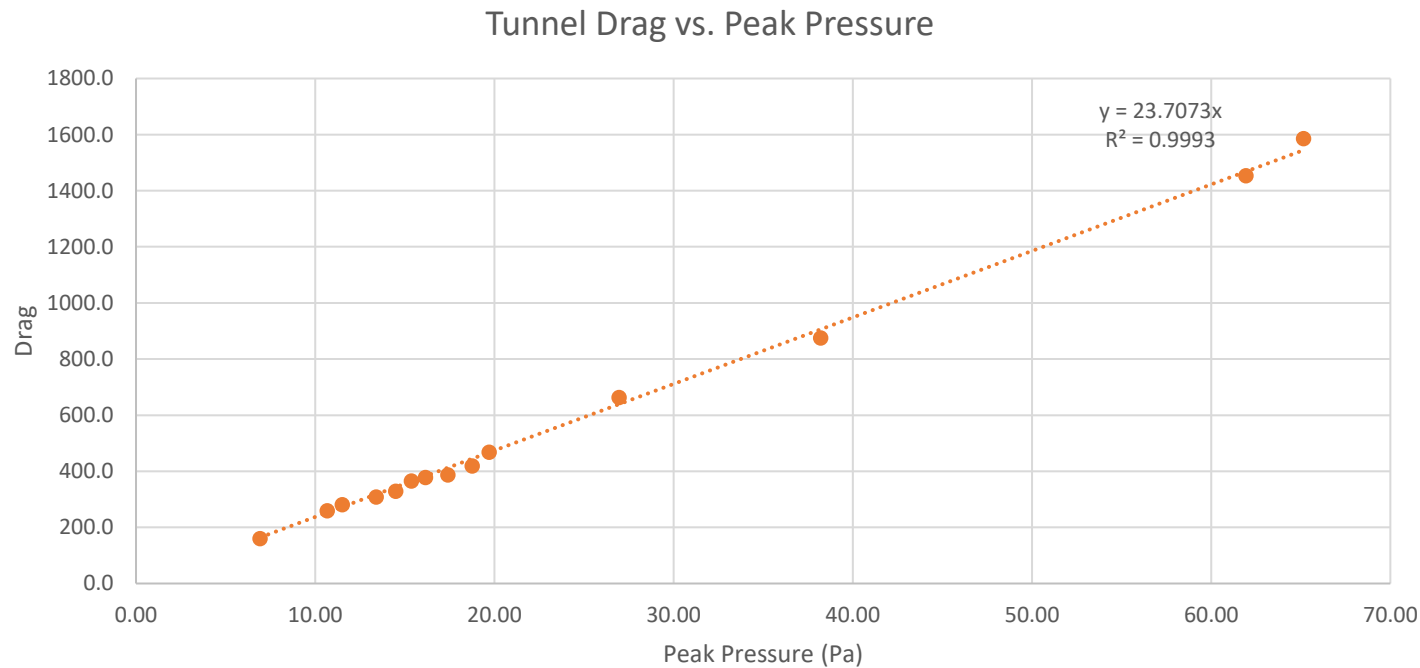
Blockage Correction vs alternative methods.

Utilising this pressure signature appears to provide a better method of blockage correction with an error less than 1% for all vehicles.



What about drag prediction?!

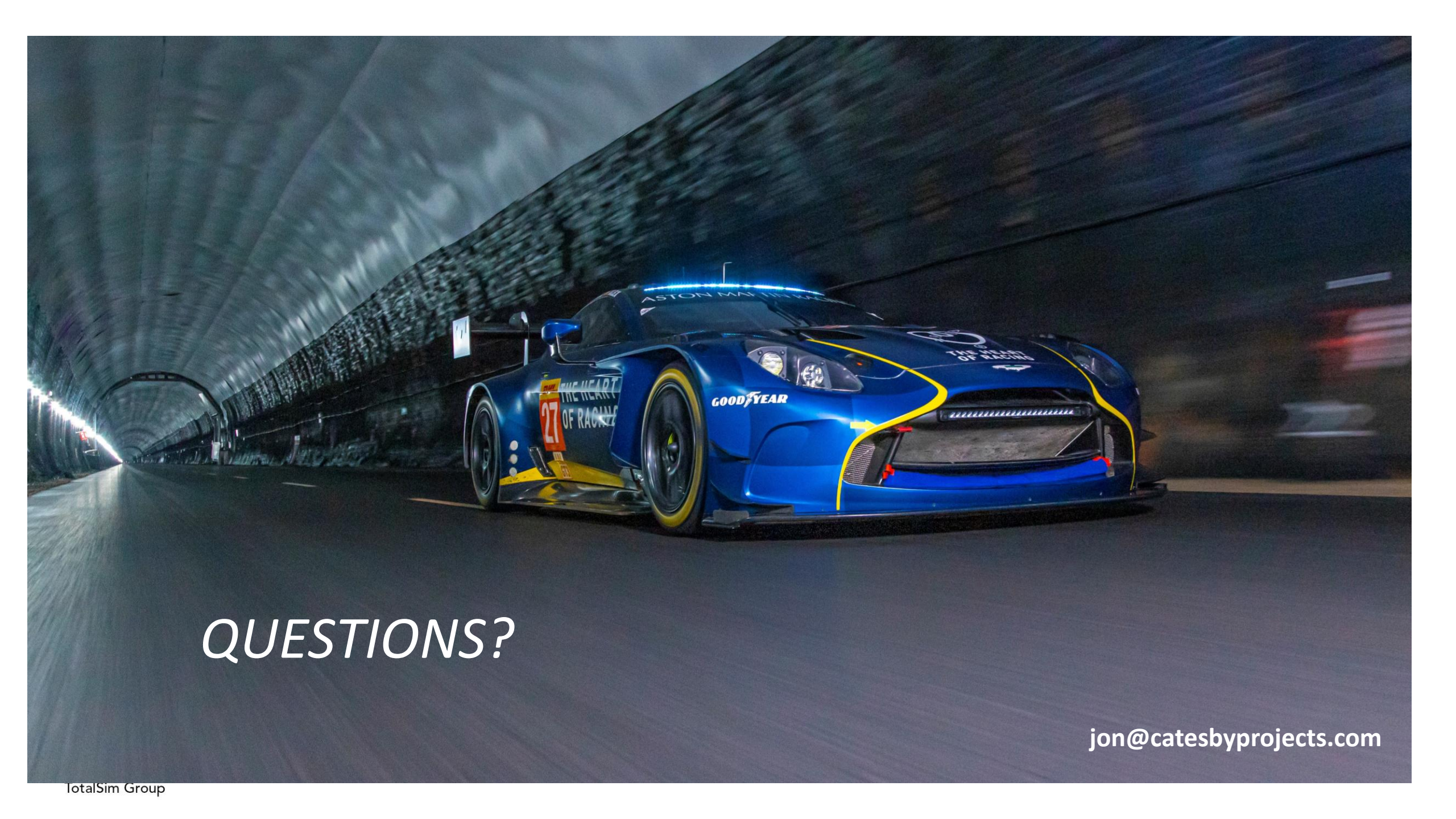
The tunnel wall pressure data may have further applications aside from blockage correction. For example, it may be possible to obtain a rapid estimate of vehicle Drag using the pressure signature. There is a clear correlation between upstream pressure and vehicle drag, and using the trend line in the graph below, it's possible to obtain a drag estimate to within 7% from upstream pressure measurement alone. Whilst these accuracy figures will not be acceptable for many studies, they may be adequate for some first-order studies and are included in this report for completeness.



Currently theoretical/computational. Needs testing in reality.

Relatively basic training. Huge amount of data potentially.
Some complexities with speed.

Reliable data is going to be more valuable than ever in training models.



QUESTIONS?

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