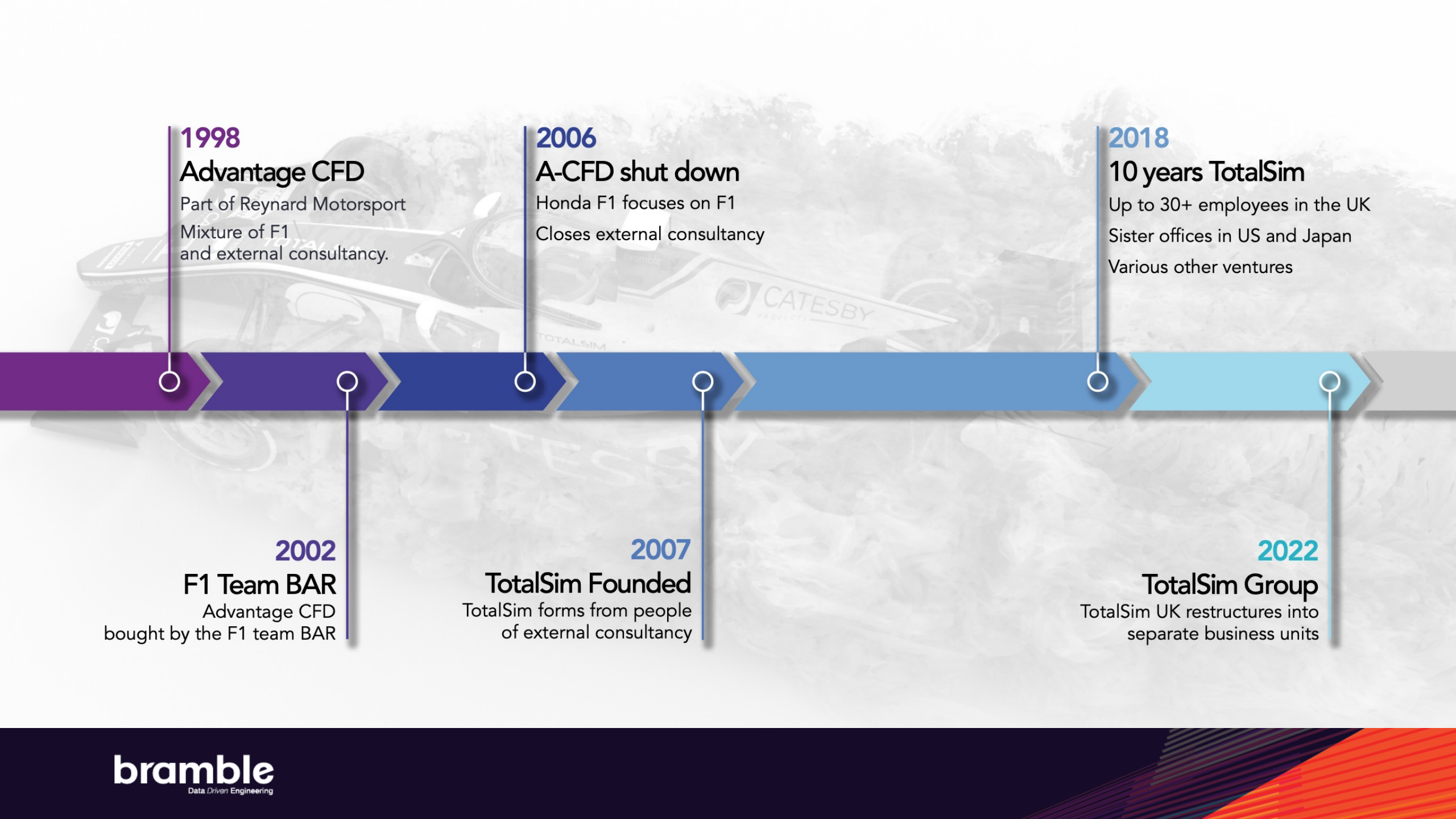
bramble
Data *Driven* Engineering

AutoCFD3 – Effect of RANS Iterations on Final DES Solution

Ivor Annetts – Bramble CFD / TotalSim Limited



1998
Advantage CFD
Part of Reynard Motorsport
Mixture of F1
and external consultancy.

2002
F1 Team BAR
Advantage CFD
bought by the F1 team BAR

2006
A-CFD shut down
Honda F1 focuses on F1
Closes external consultancy

2007
TotalSim Founded
TotalSim forms from people
of external consultancy

2018
10 years TotalSim
Up to 30+ employees in the UK
Sister offices in US and Japan
Various other ventures

2022
TotalSim Group
TotalSim UK restructures into
separate business units

CATESBY TUNNEL

VORTEQ

SILVERSTONE SPORTS ENGINEERING HUB

TOTALSIM GROUP

TOTALSIM CFD

CATESBY PROJECTS

bramble Data Driven Engineering

Test Cases 2a and 2b

Mesh and solved using TotalSim's customised version of OpenFOAM.

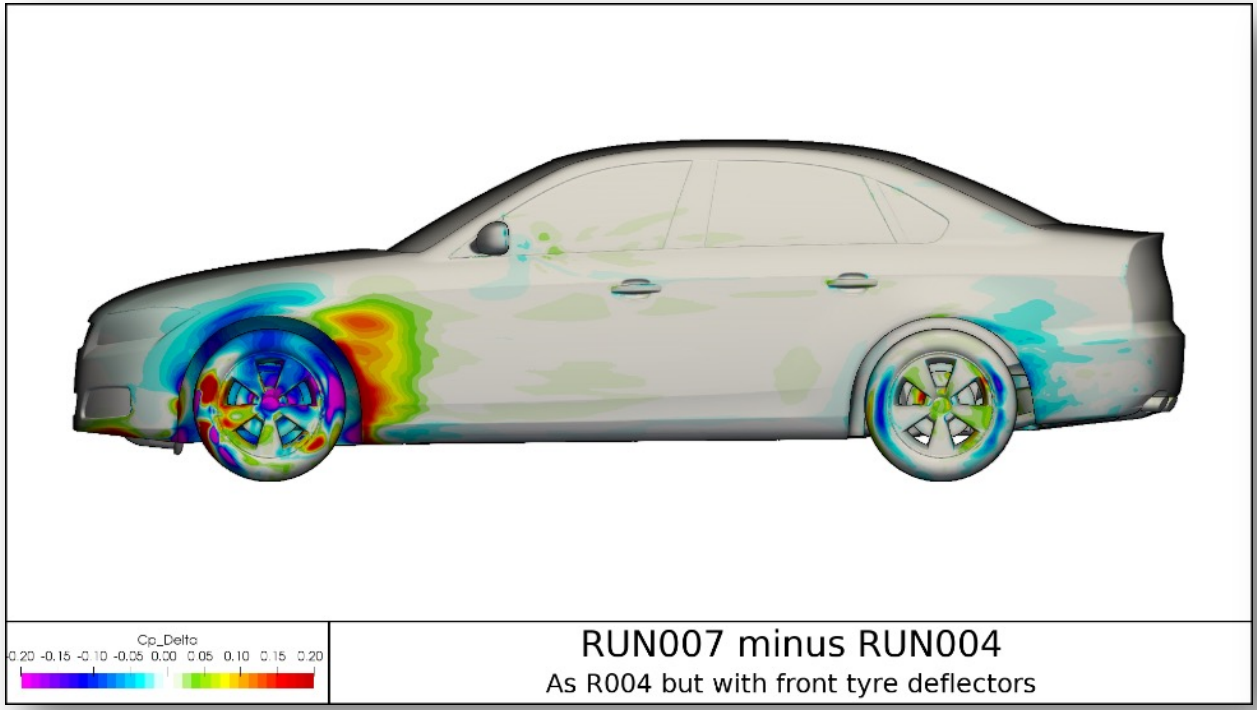
TSFoam is derived from v1806 with additional codes for improved usability.

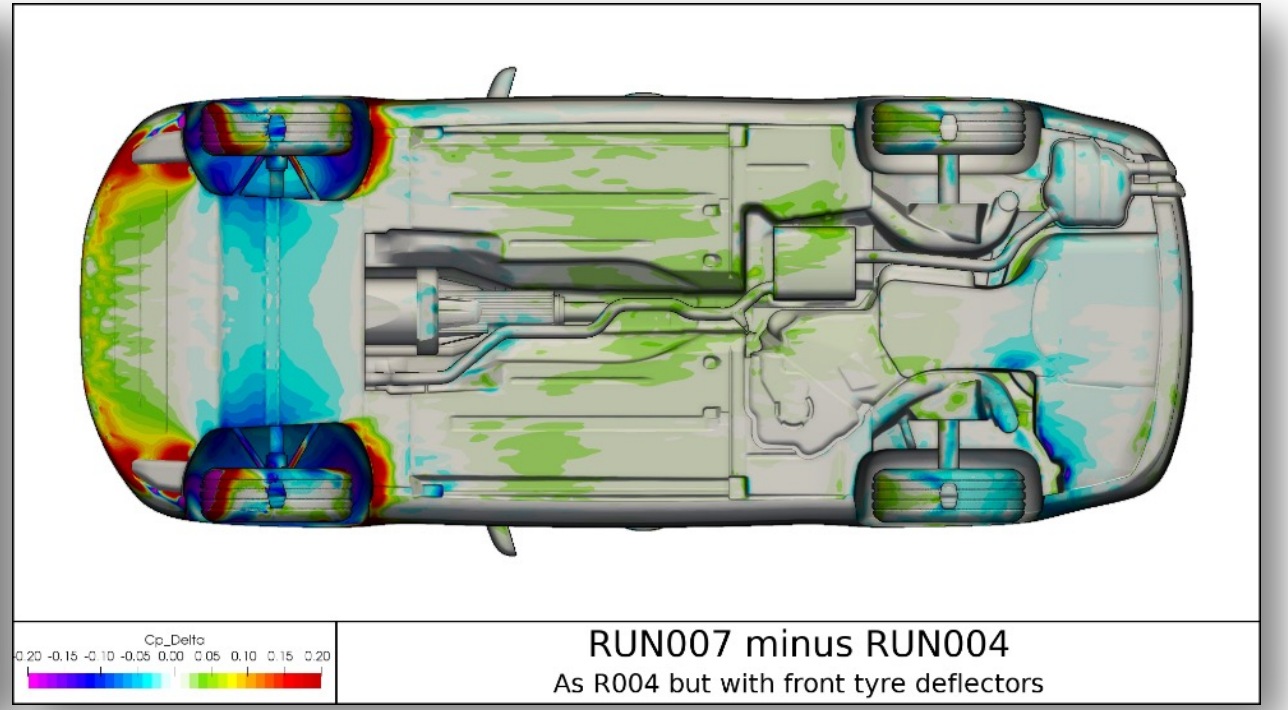
Custom 'look-up wall functions' based on work by Kalitzen et al (2005).

snappyHexMesh recipe attempts to replicate supplied mesh.

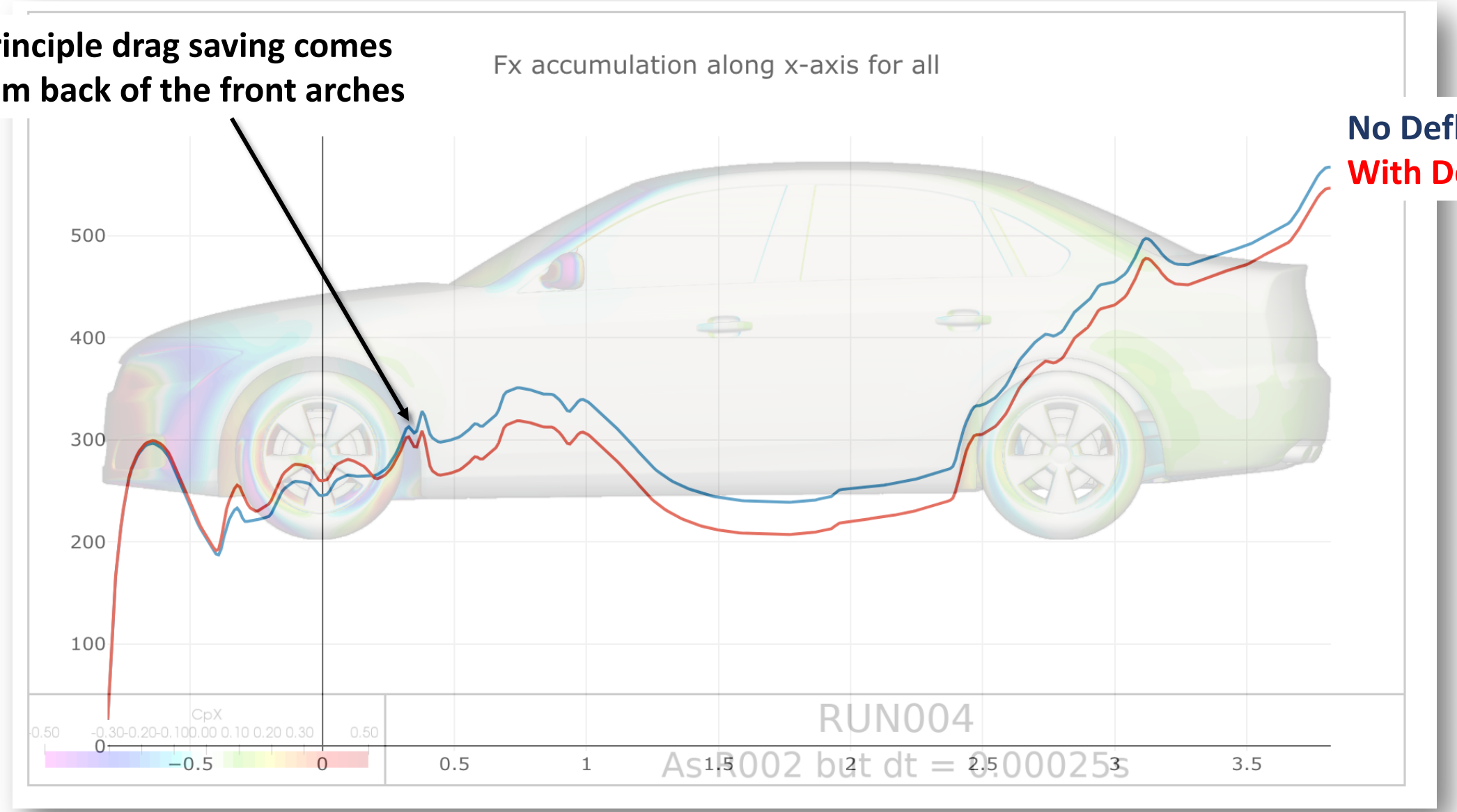
Kalitzen G, Medic G, Iaccarino I and Durbin P, "Near-wall behaviour of RANS turbulence models and implications for wall functions" Journal of Computational Physics, **204** (2005), 261—291.

No Deflector:	$C_D = 0.278$	$C_L = 0.023$	$C_{LF} = -0.066$	$C_{LR} = 0.089$
With Deflector:	$C_D = 0.270$	$C_L = 0.030$	$C_{LF} = -0.060$	$C_{LR} = 0.090$
	-0.008	**0.007**	**0.006**	**0.001**





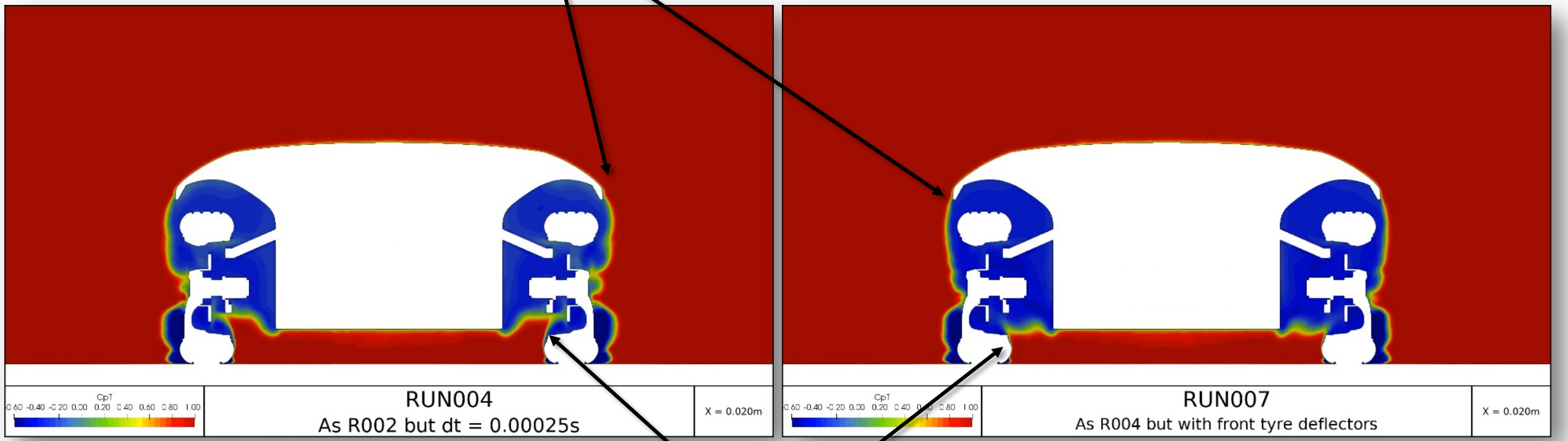
Principle drag saving comes from back of the front arches



No Deflector:

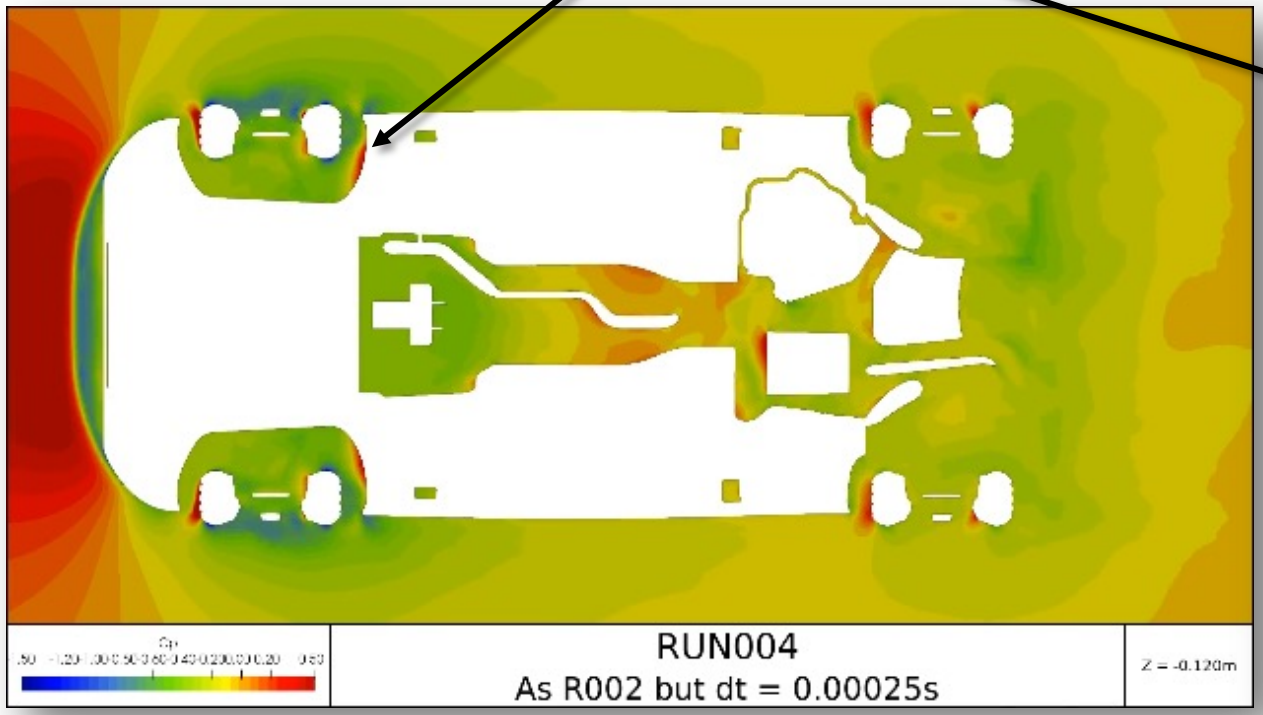
With Deflector:

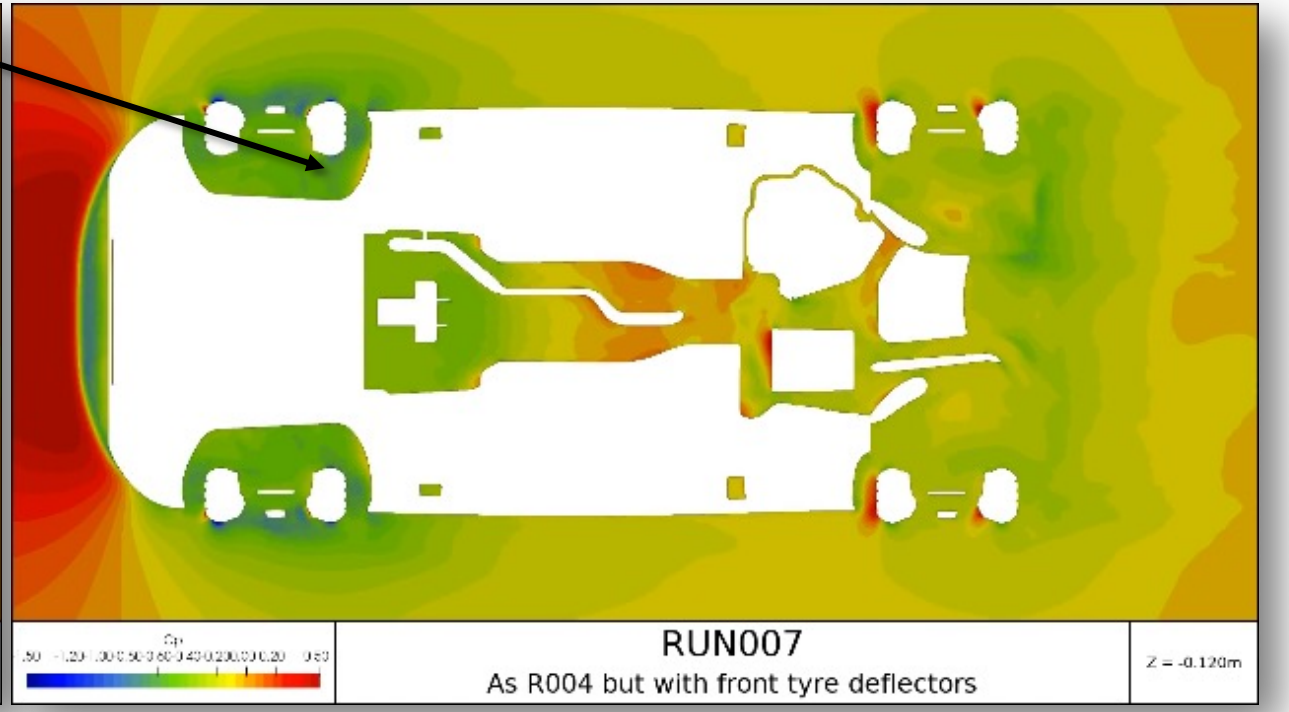
Reduction in wake spilling from wheel and arch.



Less flow coming up and into the wheel arch

Reduction in high energy flow hitting the rear of the front arch results in lower pressures and so, less drag



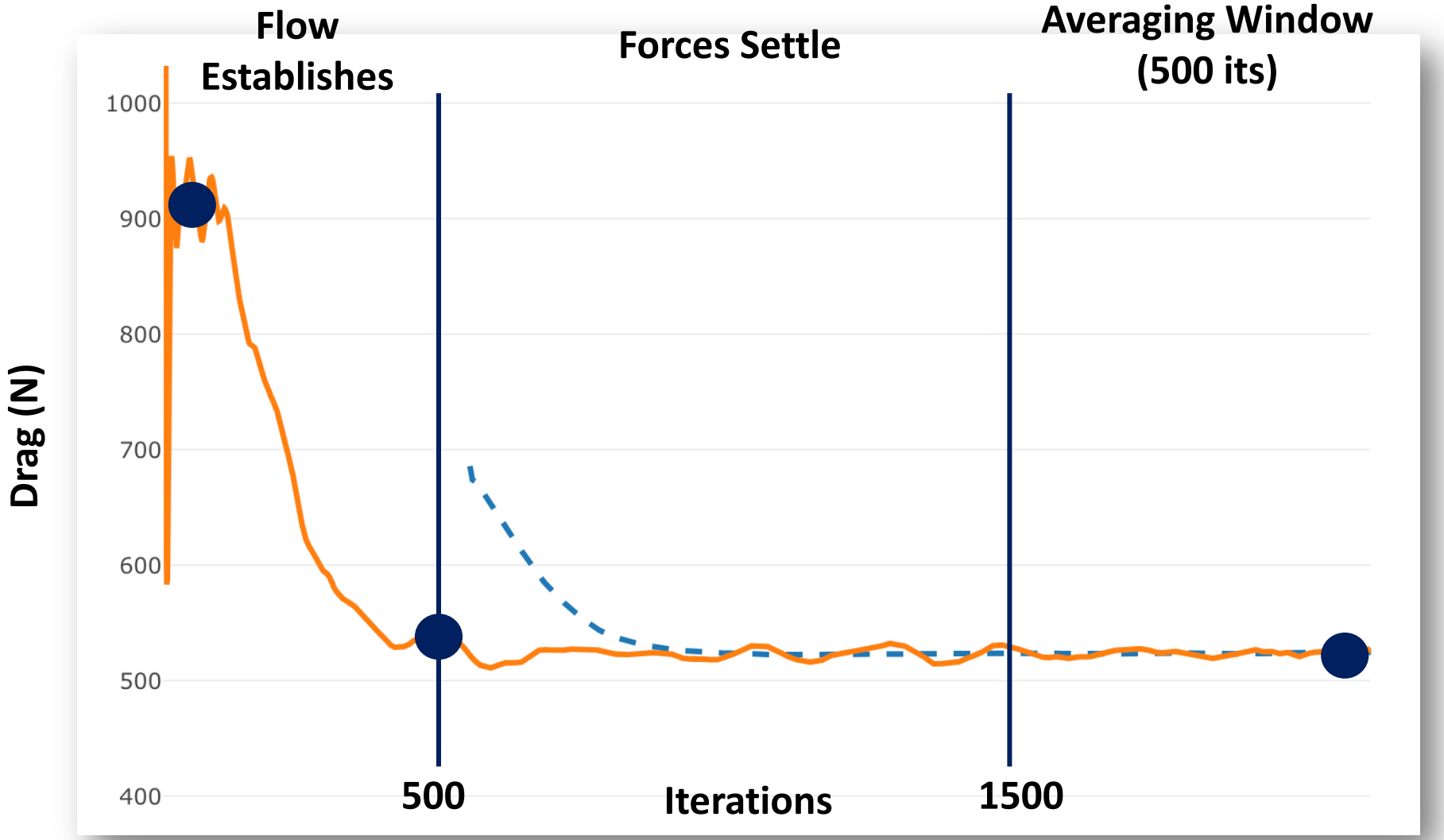


Effect of RANS of Iterations on DES Solution

RANS solutions are commonly used as a start point for a DES solve.

- **Provides a stable start point.**
- **Less computational effort to establish flow structures.**

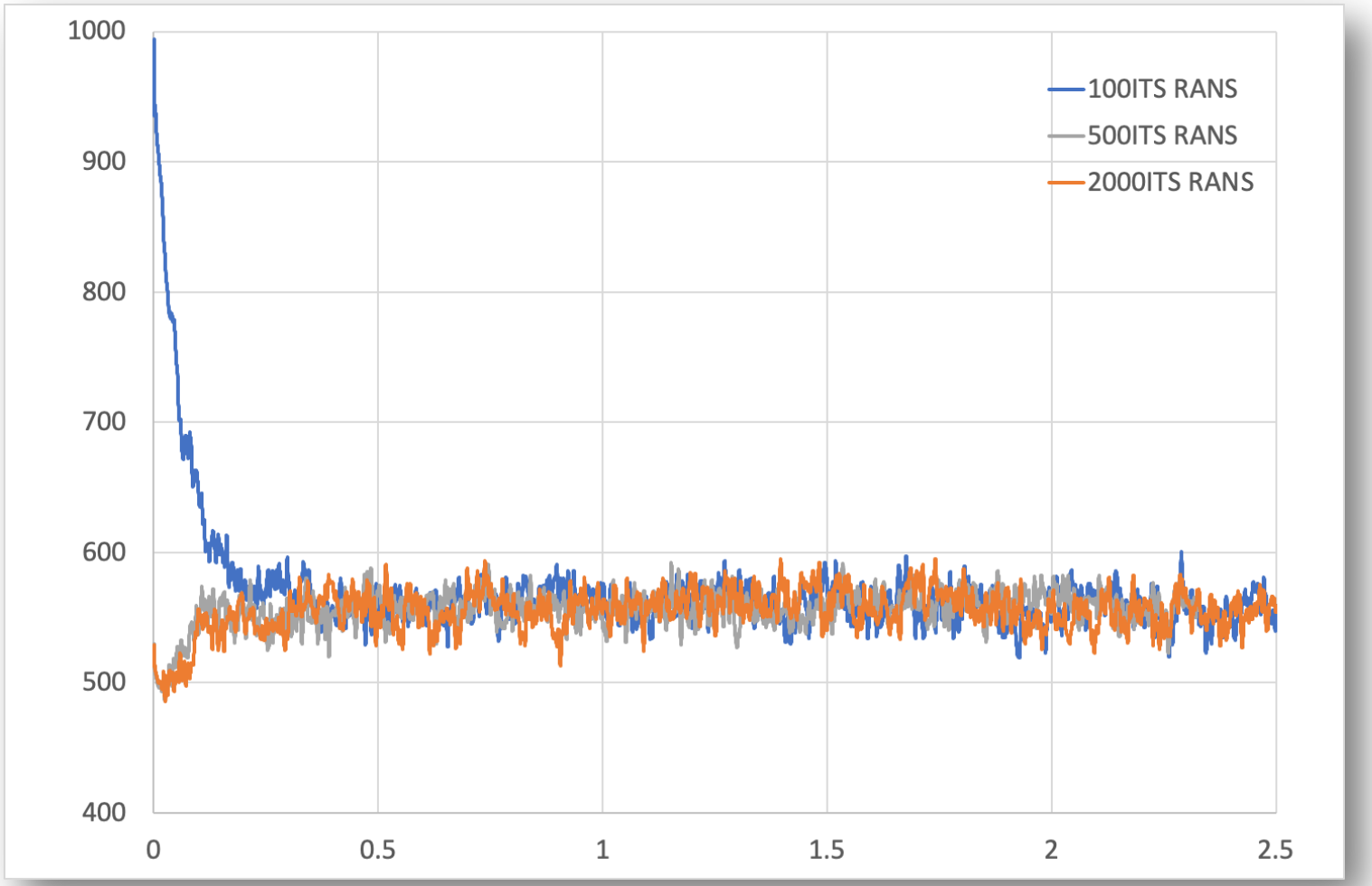
How converged does the RANS solution need to be?



Three DES solves completed with solutions initialised from:

100 its
500 its
2000 its

Variation of Drag (N) with Time (s)



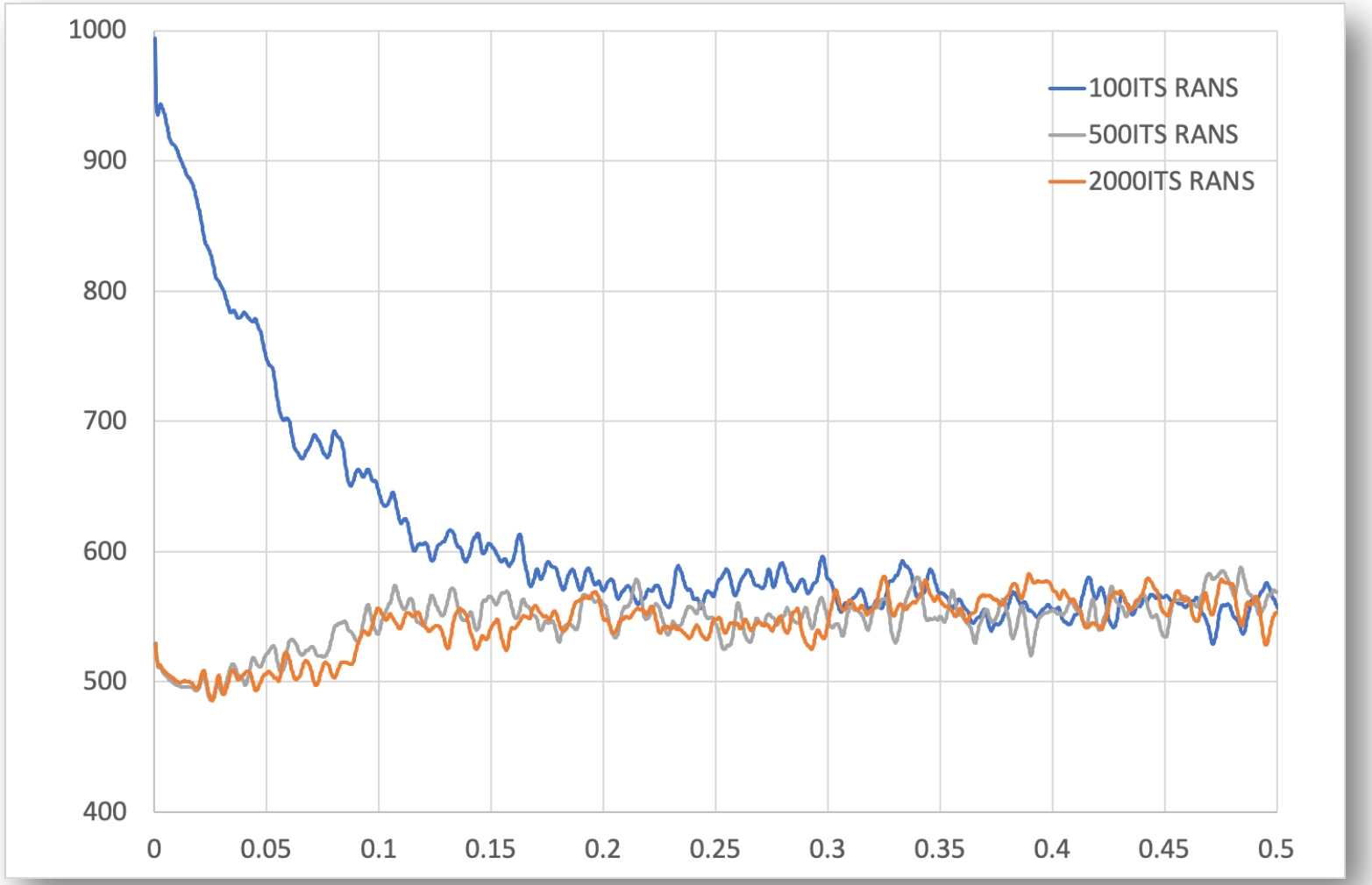
All three solutions converge to a similar drag level

100 its $C_D = 0.278$

500 its $C_D = 0.278$

2000 its $C_D = 0.277$

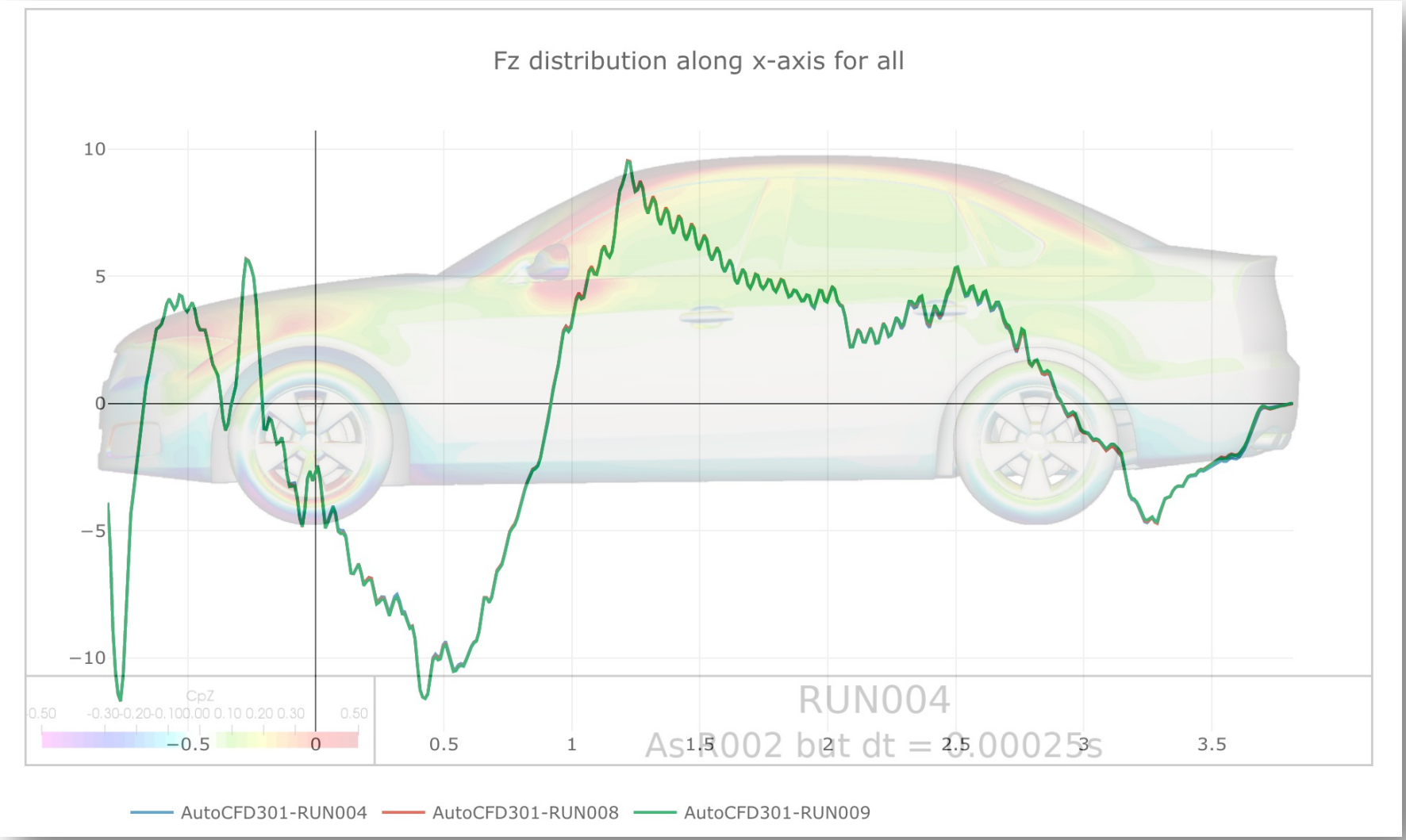
Variation of Drag (N) with Time (s) – FIRST 0.5s



100its solution takes 0.1 – 0.2s longer to wash-out.

Which is 400 to 800 time-steps.

Lift Distribution for the Three Solutions



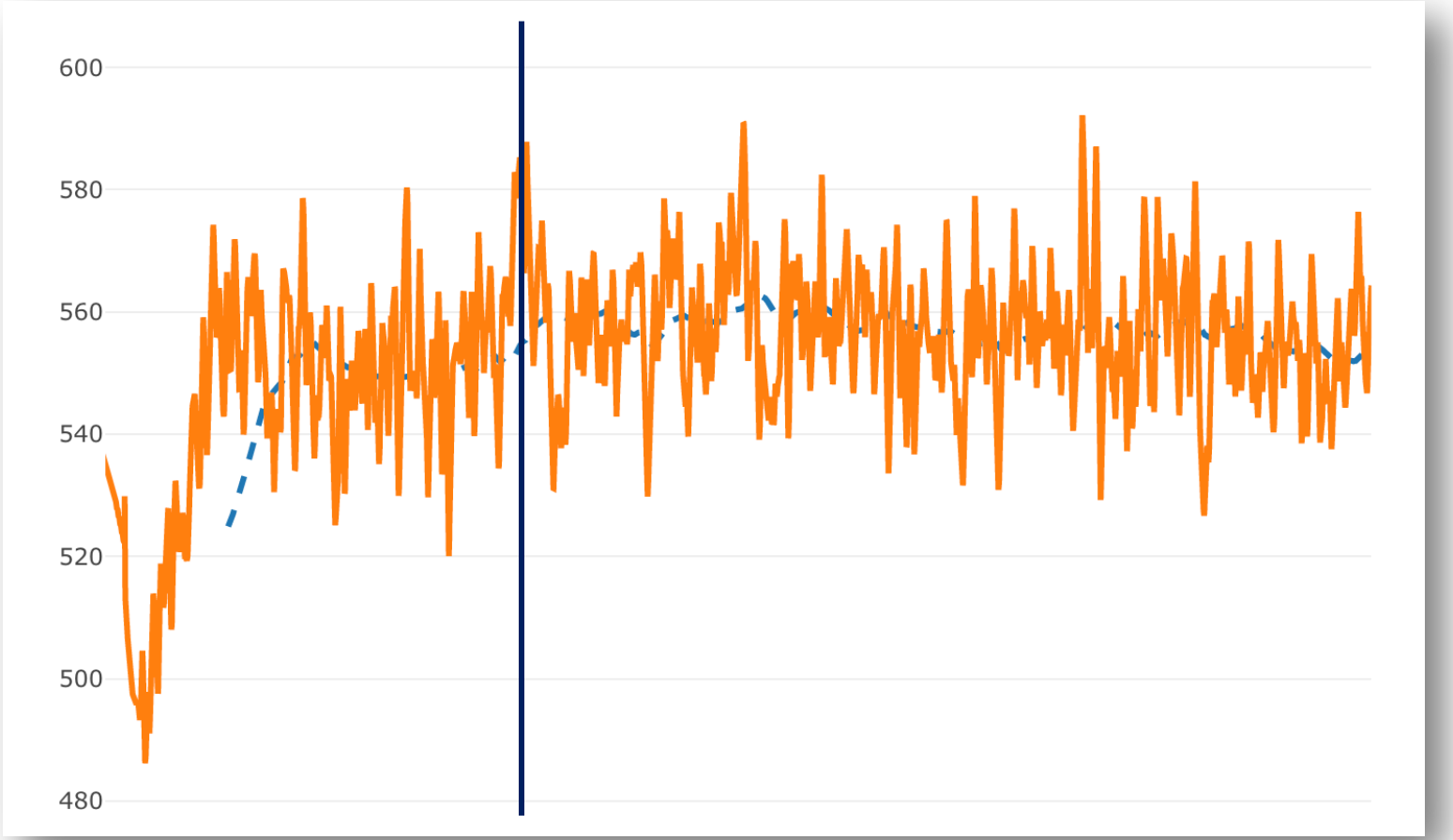
Near identical lift distributions

Increasing Timestep During RANS Wash-Out

First part of the DES solution is where the RANS flow is washed out.

We typically solve the entire DES solution at a single time-step.

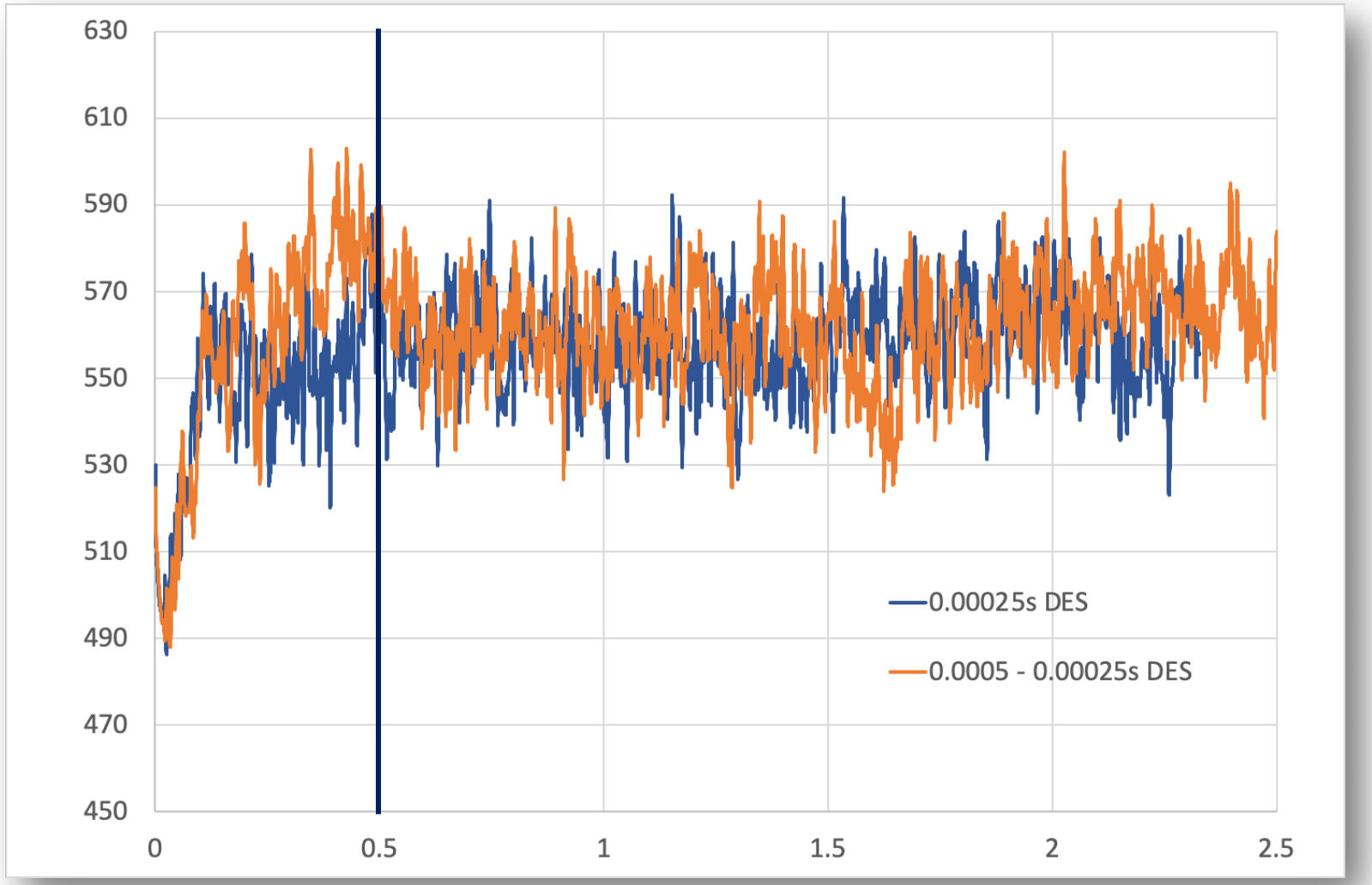
Can the solution be sped up by using a larger time-step during the RANS wash-out?



First 0.5s @ 0.0005s/time step

Remainder @ 0.00025s/time step

Variation of Drag (N) with Time (s)



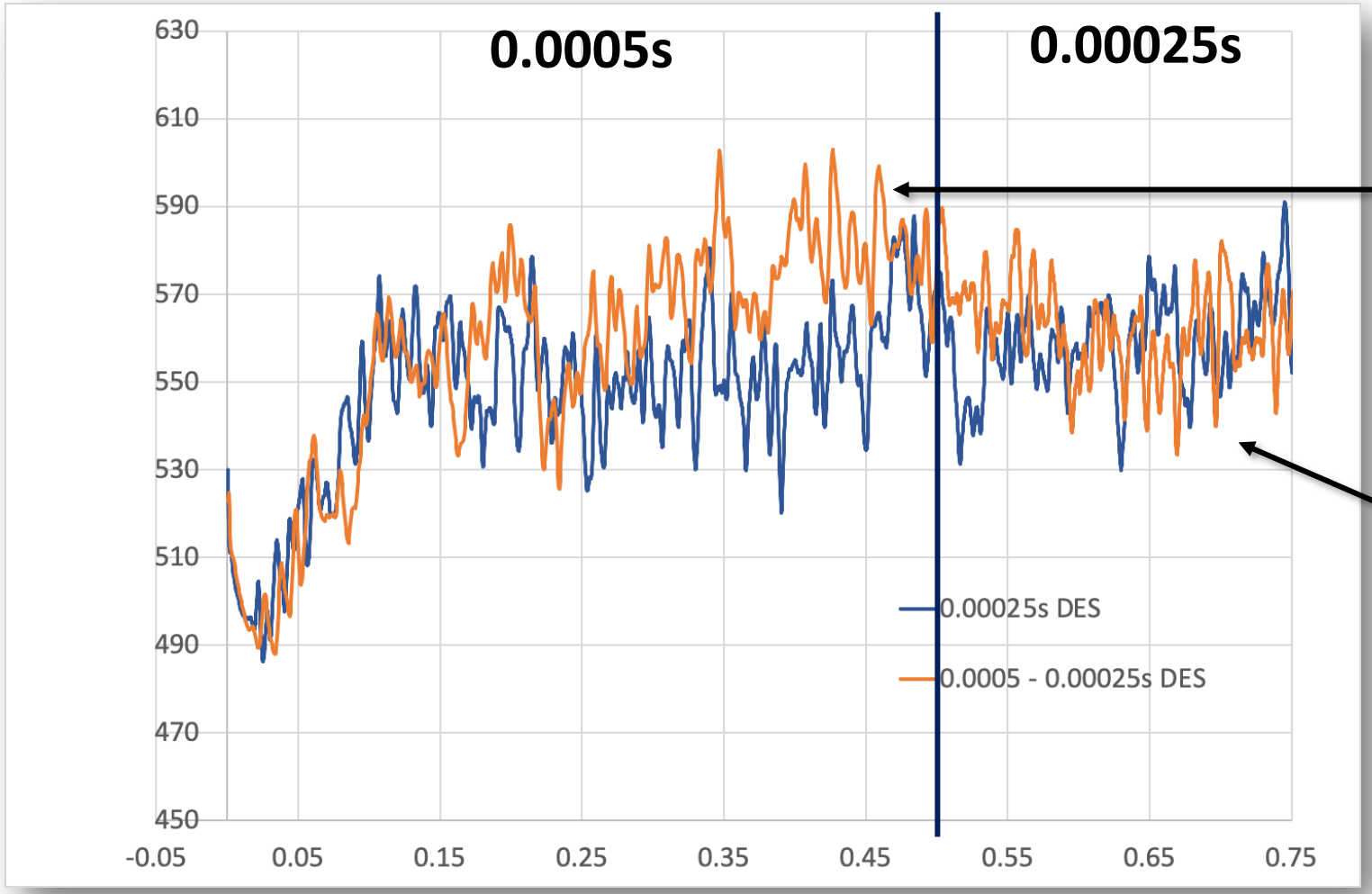
Drag (N)

Time (s)

Solutions settle to a similar drag level

One Time Step	$C_D = 0.278$
Dual Time Step	$C_D = 0.279$

Variation of Drag (N) with Time (s) – First 0.75s



Drag *potentially* at a higher level with larger timestep

Solution quickly settles to same level once changed to 0.00025s

Bramble CFD Limited
c/o TotalSim Limited
Catesby Innovation Centre, Catesby Park
Banbury Rd, Charwelton
Northamptonshire
NN11 3FQ

t: +44 (0) 1327 630 301
e: info@bramblecfd.com

bramblecfd.com