

ADJOINT CFD FOR RAPID DESIGN OPTIMISATION

Cooperation with RevDop

Thomas Schumacher

Gothenburg OF 2018

21. November 2018



CONTENTS

1. Introduction to RevDop
2. BMW N54 Airbox
3. VW TDI/TSI Airbox
4. Conclusion

RevDop GmbH



- › StartUp company near Berlin, Germany
- › www.revdop.de
- › Providing optimised parts for combustion engine systems to the car tuning community
- › Designs “inspired by nature”
- › Cooperation in employing HELYX-Adjoint since 2016 after benchmarking several software solutions
- › First product to market 2018



Car Tuning



BMW N54 Airbox

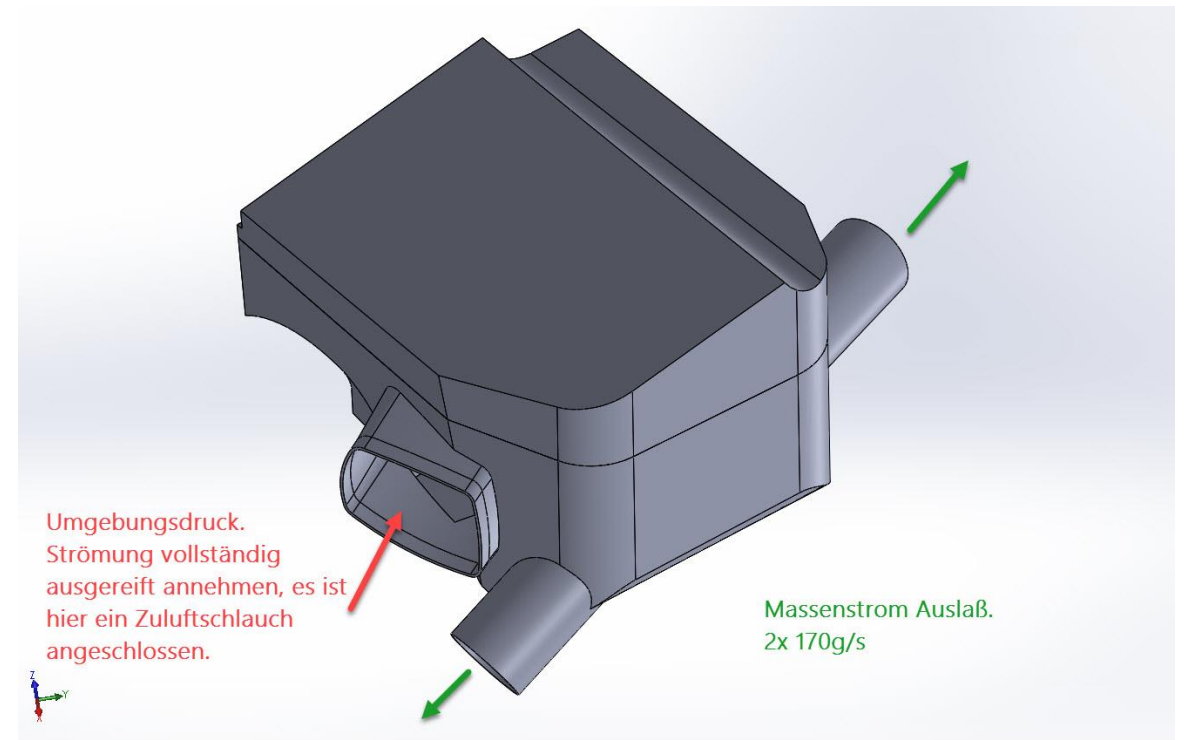
- › Twin-turbo-charged straight6 petrol engine; in production 2006 to 2016
- › Versions from 300-400HP
- › Used in 1-series, 3-series, 5-series, X6, Z4



N54 Baseline & Design Space

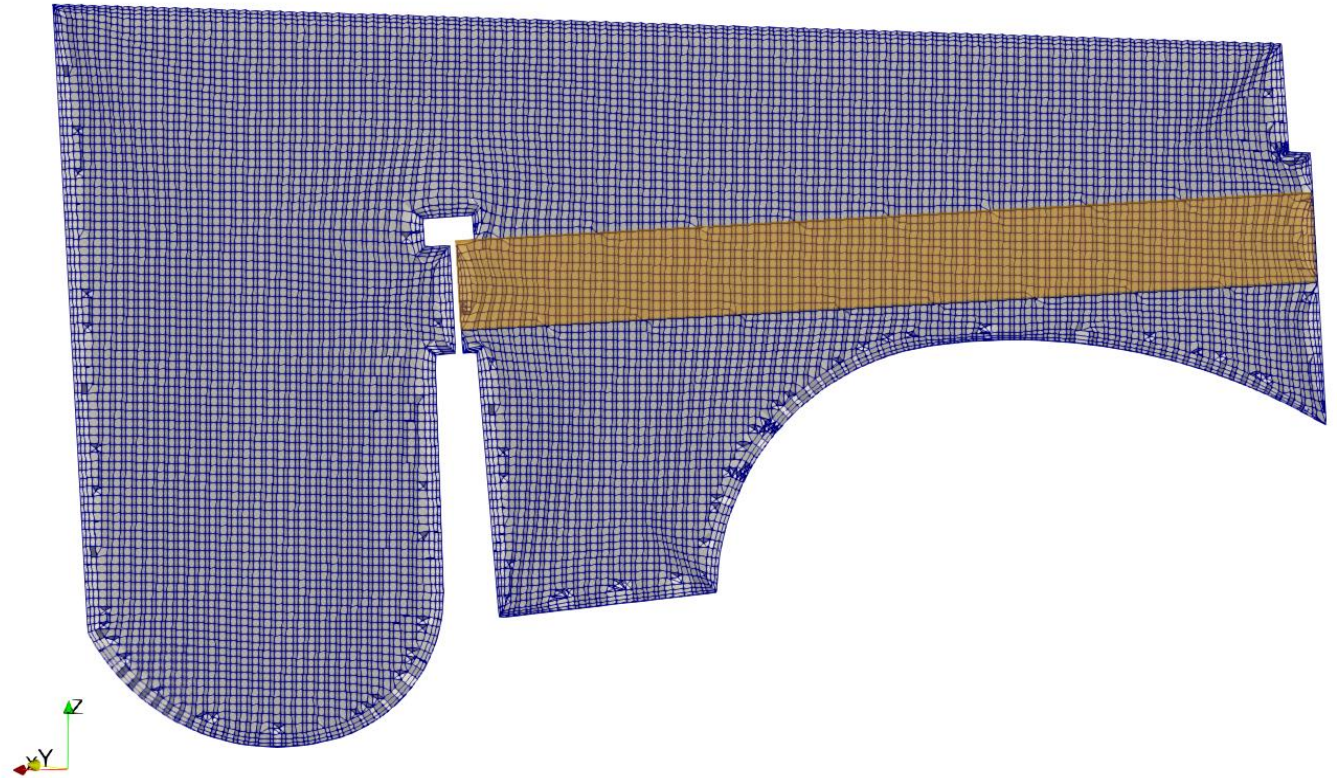
- › Baseline
 - Original BMW part
 - Scanned & reversed engineered
- › 1 inlet
- › 2 outlets towards the turbo chargers
- › Air filter → porous media

- › Design space
 - Provided by RevDop
 - Removed internal structure



N54 Adjoint Setup

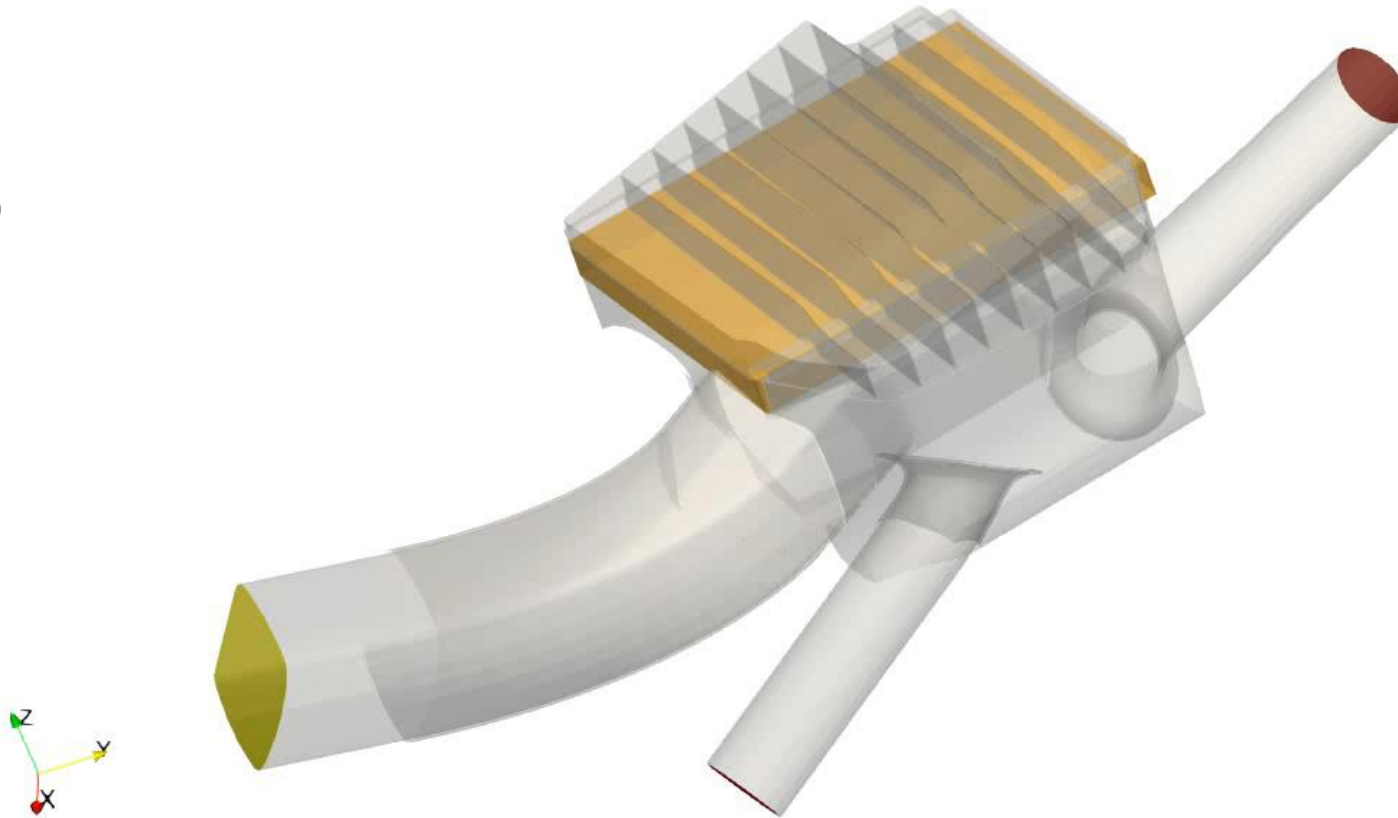
- › 1.5M cells (helyxHexMesh)
- › 340g/s massflow
- › Pressure loss objective
- › Massflow split objective
- › Curvature objective via levelSet topology method



N54 Baseline

Pressure Drop

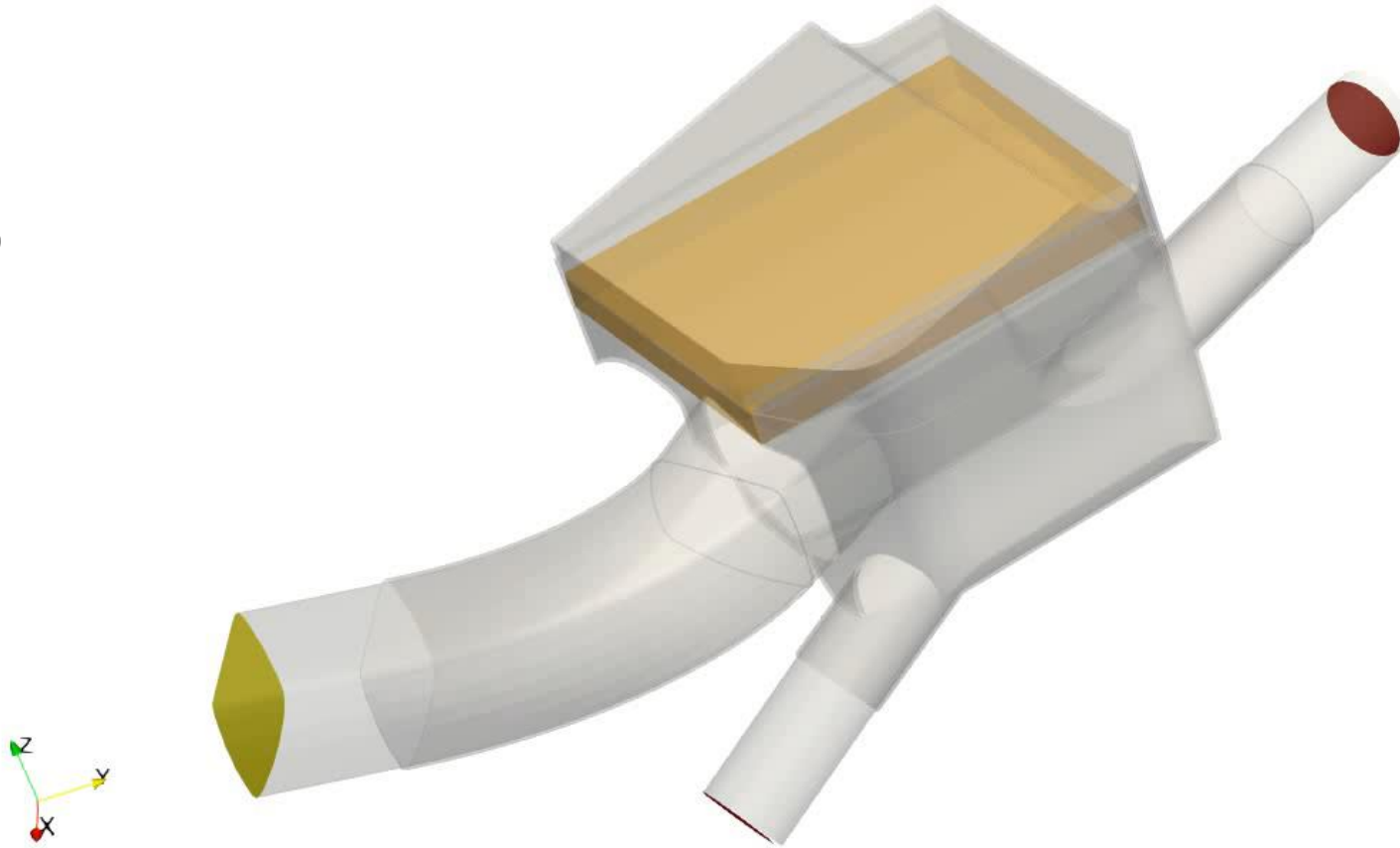
100%



N54 Design Space

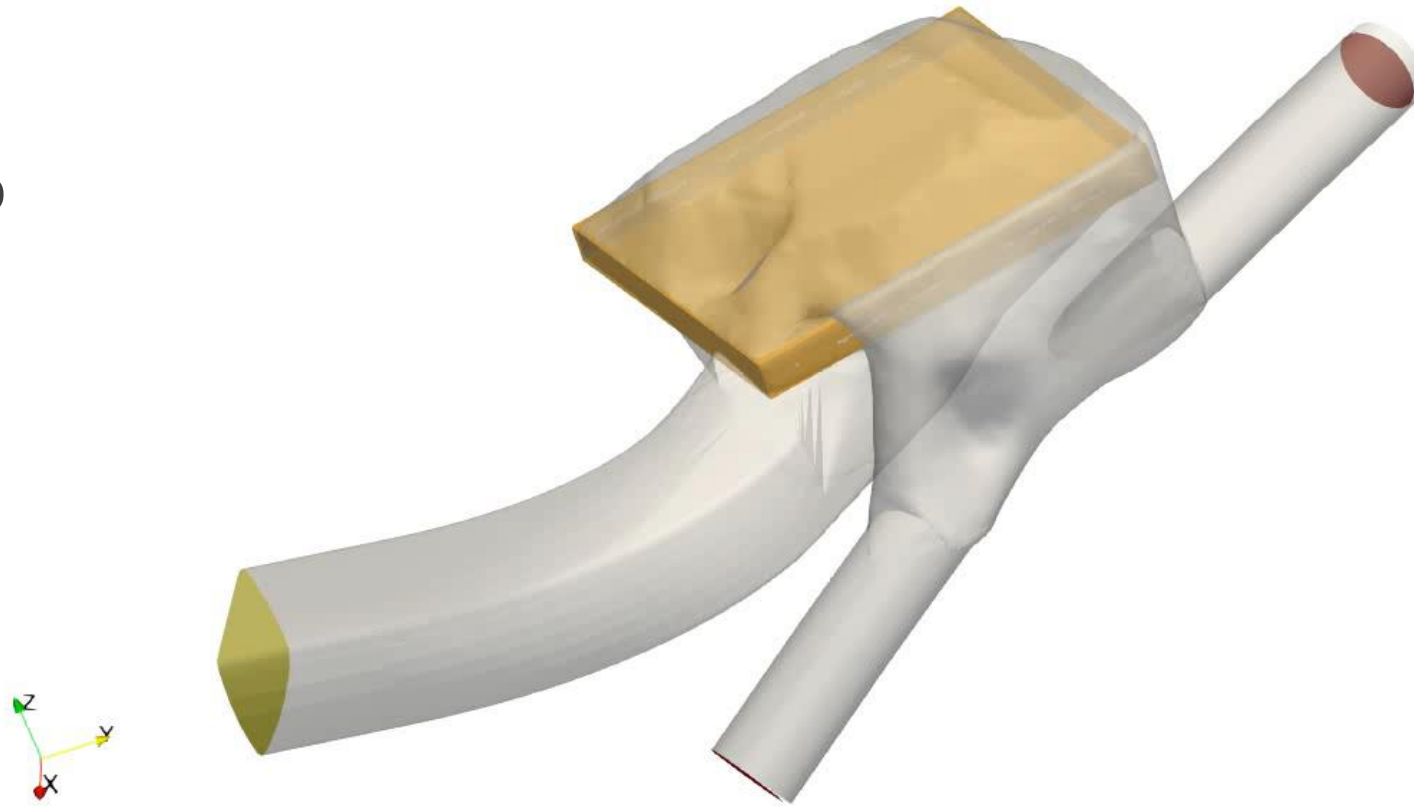
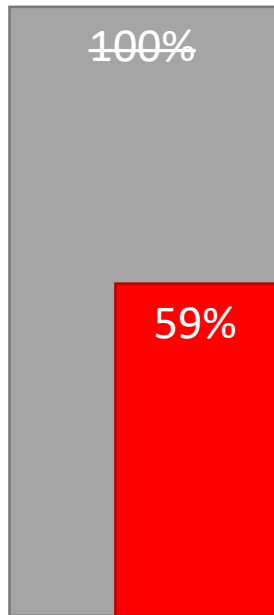
Pressure Drop

100%



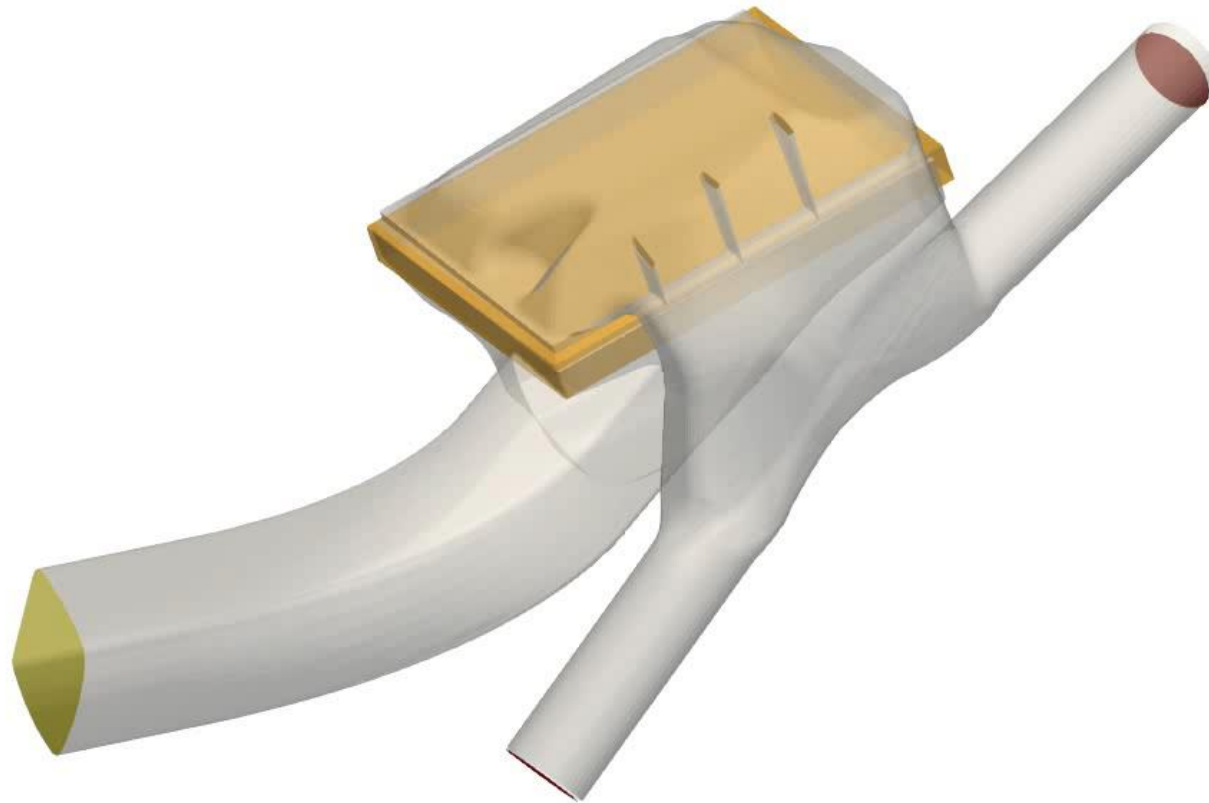
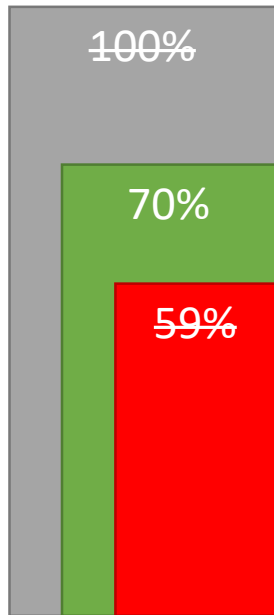
N54 Adjoint Design

Pressure Drop



N54 Final Design – Manufacturing

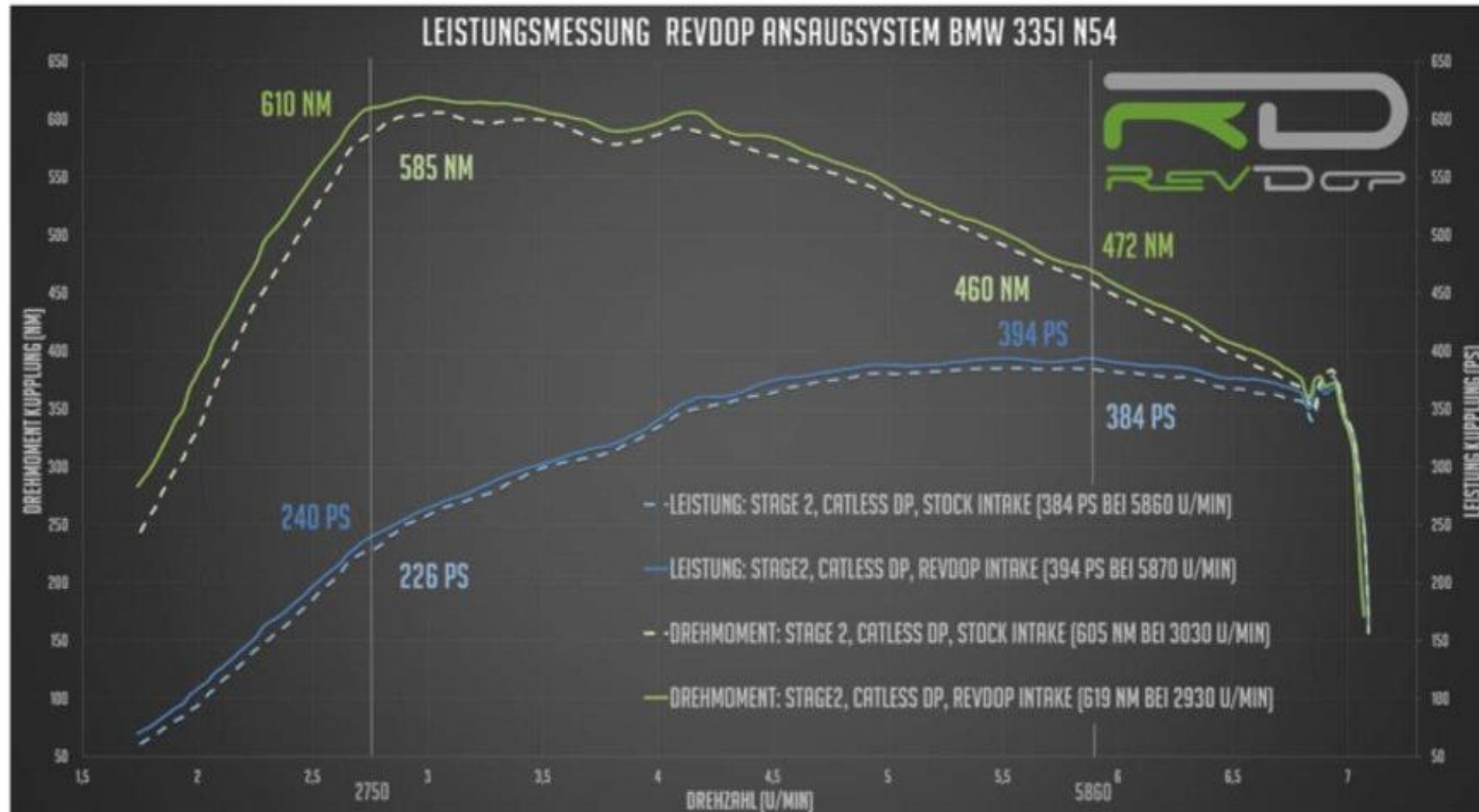
Pressure Drop



N54 Airbox Product

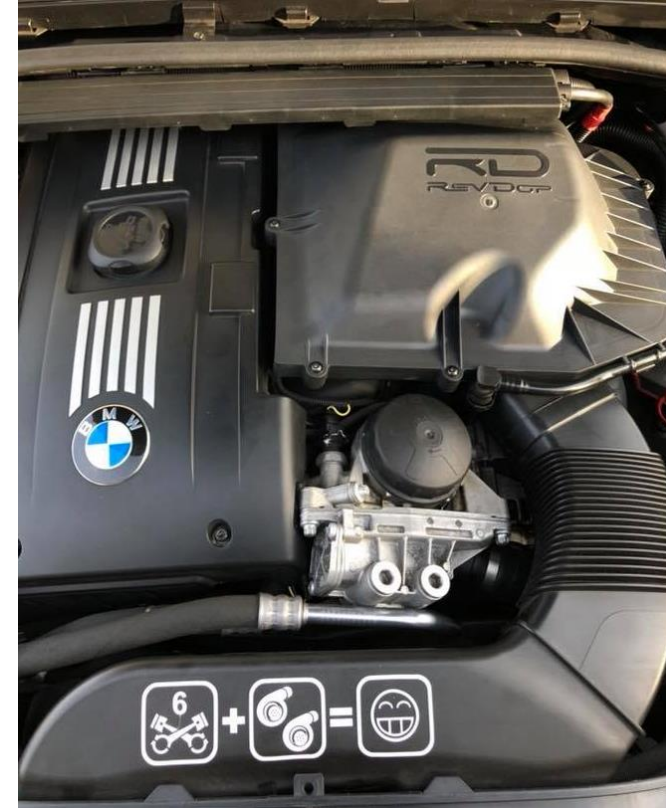


N54 Airbox Benchmark



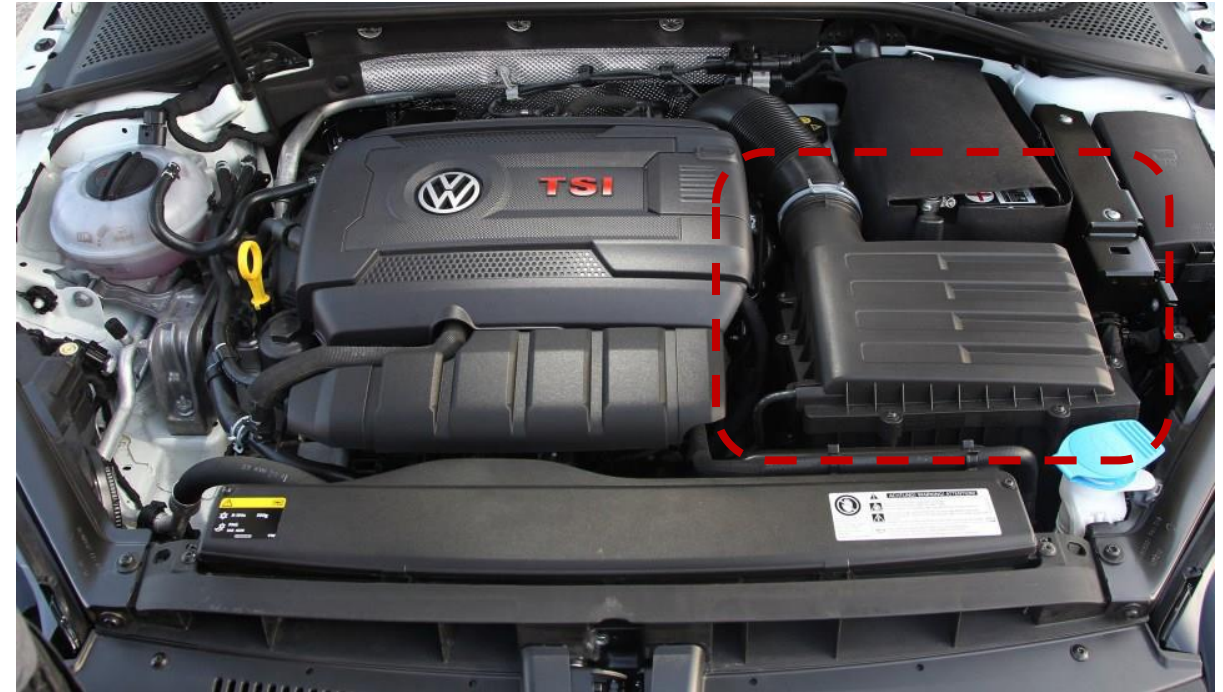
N54 Airbox Product

- › 30% reduction in pressure loss in air intake for final design (41% for adjoint design)
- › Up to 16HP increase
- › Up to 25Nm increase
- › Improvement at all engine RPMs
- › TÜV certified (=authority approved)
- › ~600€



VW TDI/TSI – Airbox

- › VAG EA288/EA888
 - VW 1.8-2.0l TDI/TSI
- › 4 cylinder Common Rail Diesel
- › In production since 2002
- › Audi, Seat, Skoda, Volkswagen



VW TDI/TSI – Airbox

- › Baseline
 - Original VW part
 - Scanned & reversed engineered
- › 1 inlet
- › 1 outlet
- › Air filter → porous media



VW TDI/TSI – Baseline

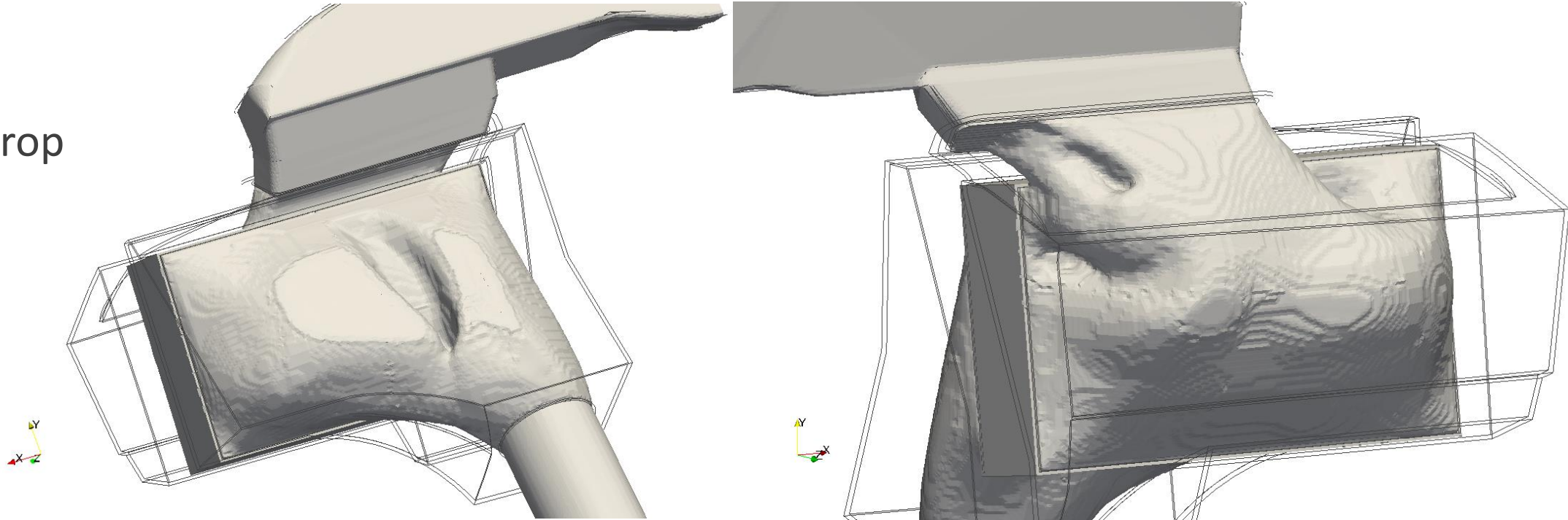
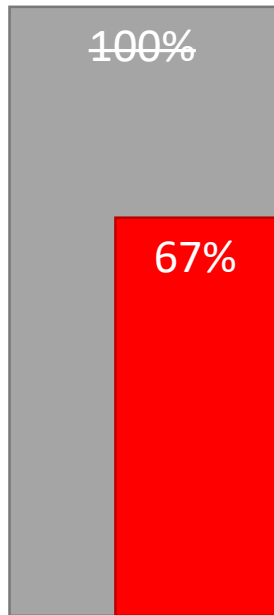
Pressure Drop

100%



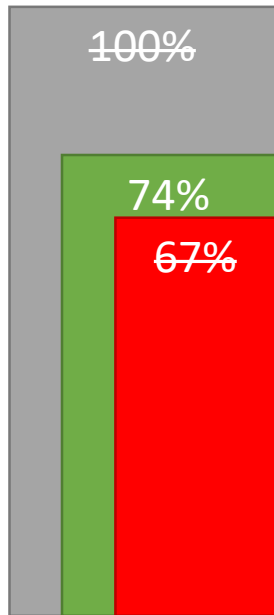
VW TDI/TSI – Design Space & Adjoint

Pressure Drop

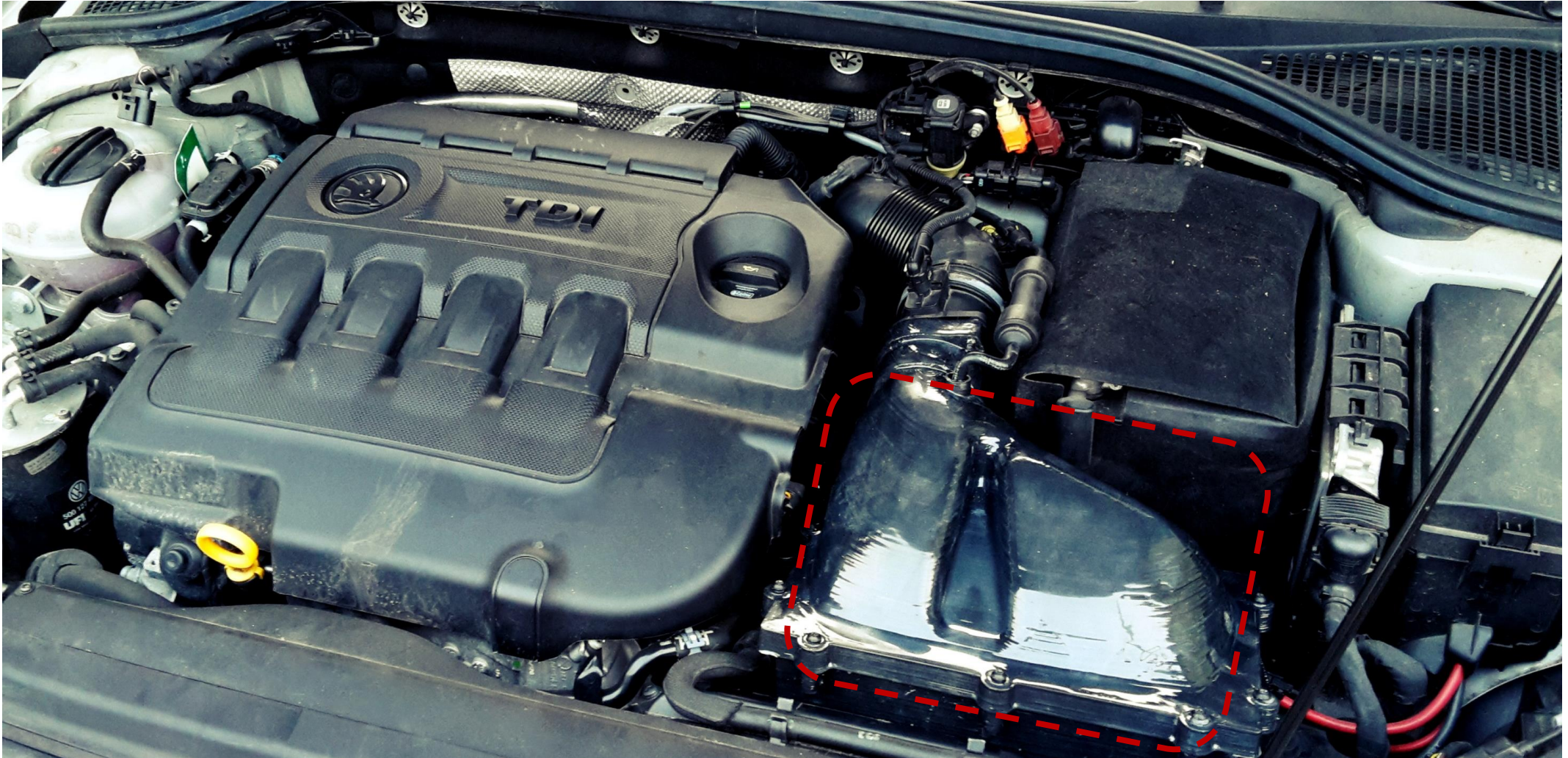


VW TDI/TSI – Final Design

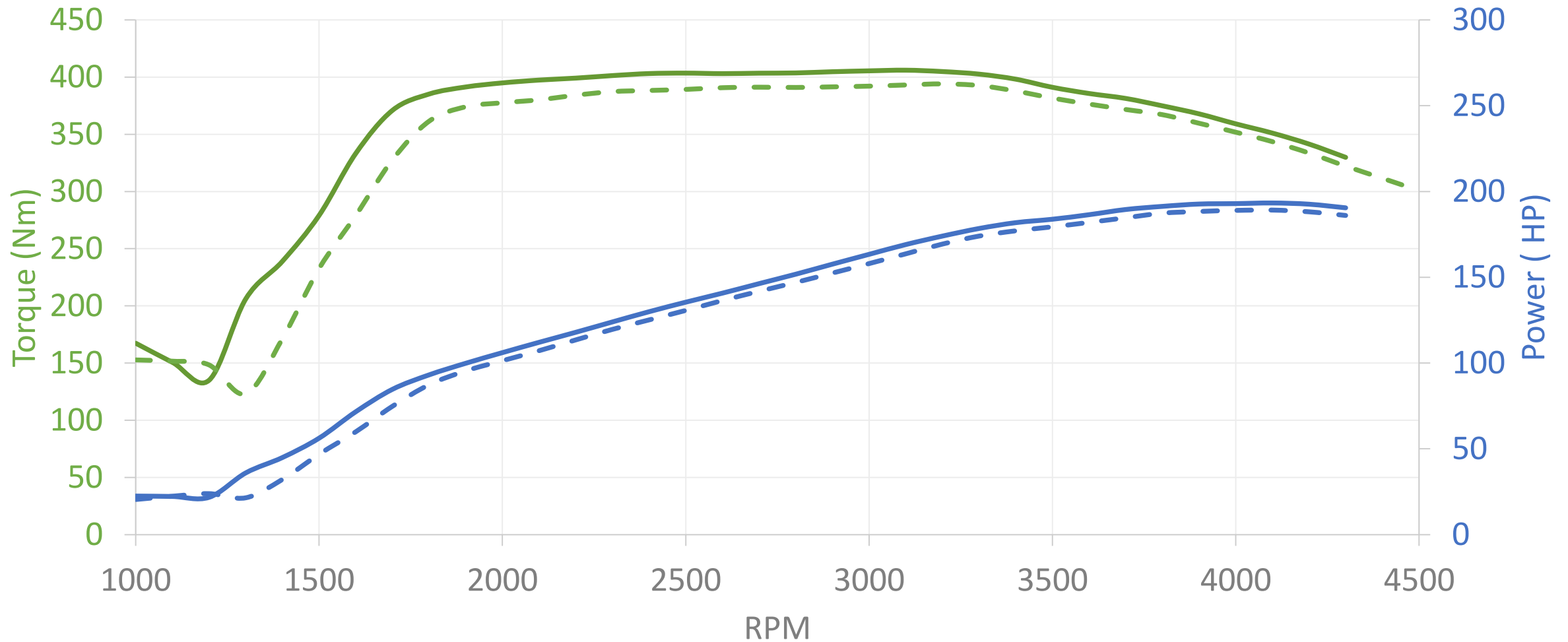
Pressure Drop



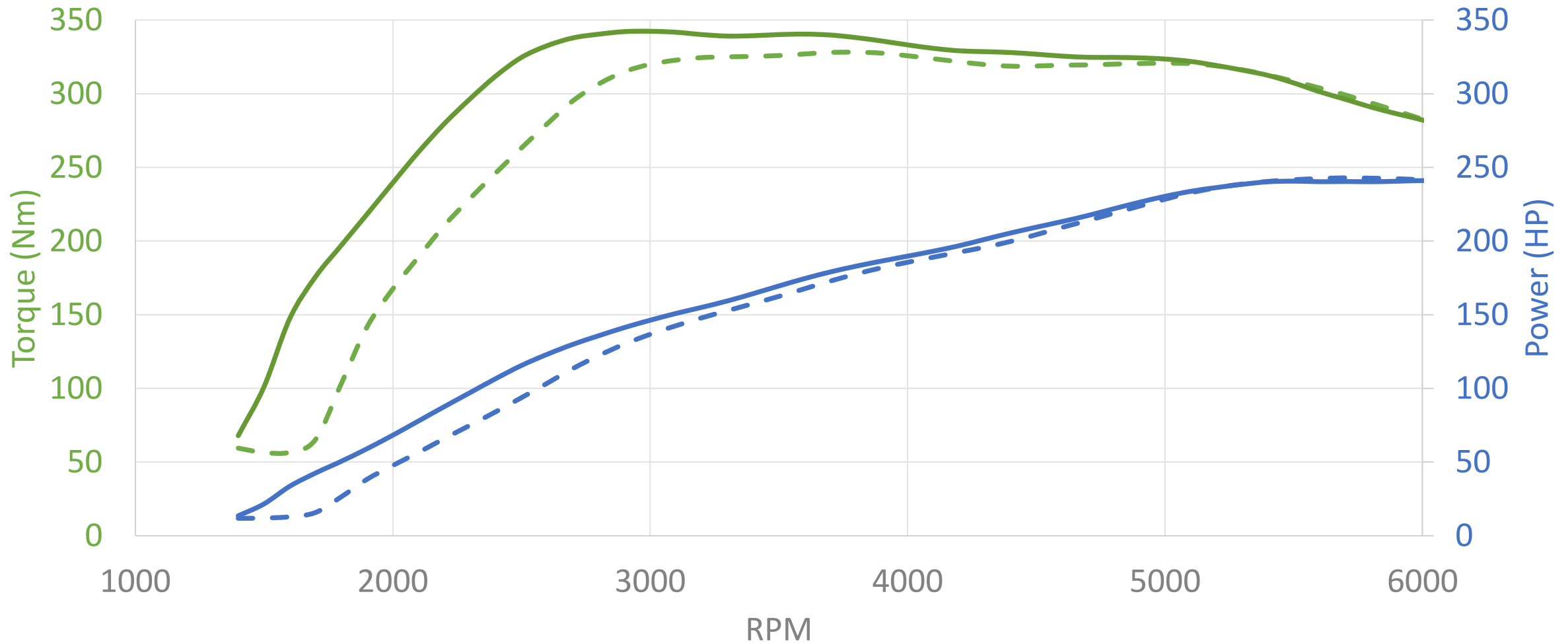
VW TDI/TSI – Benchmark



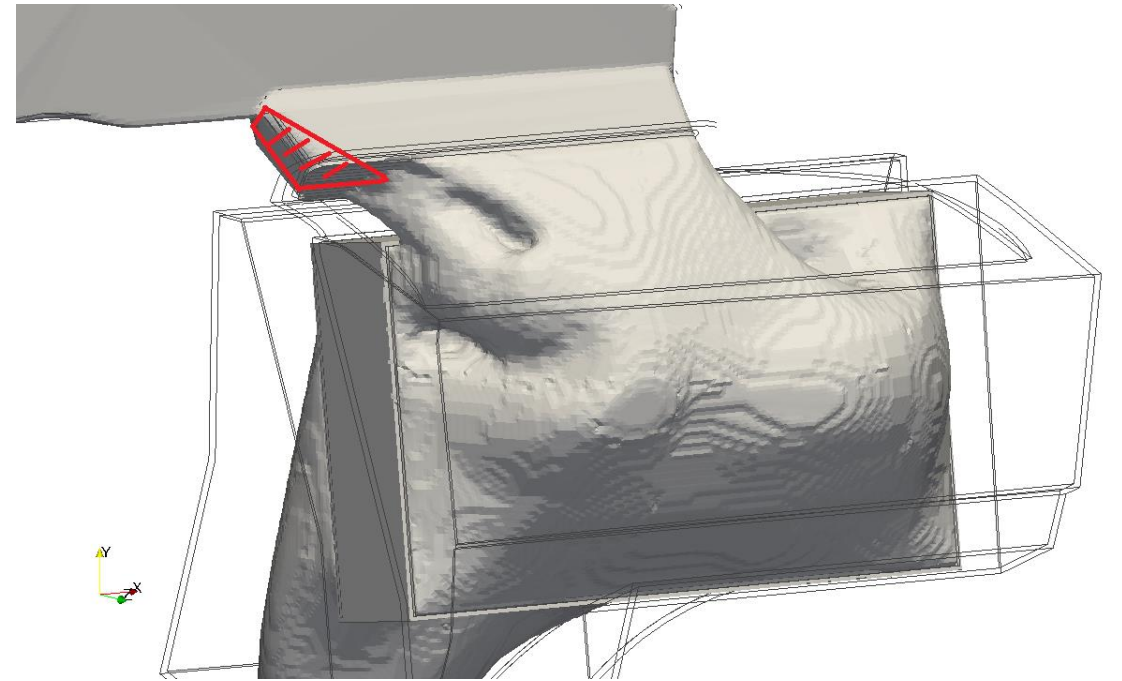
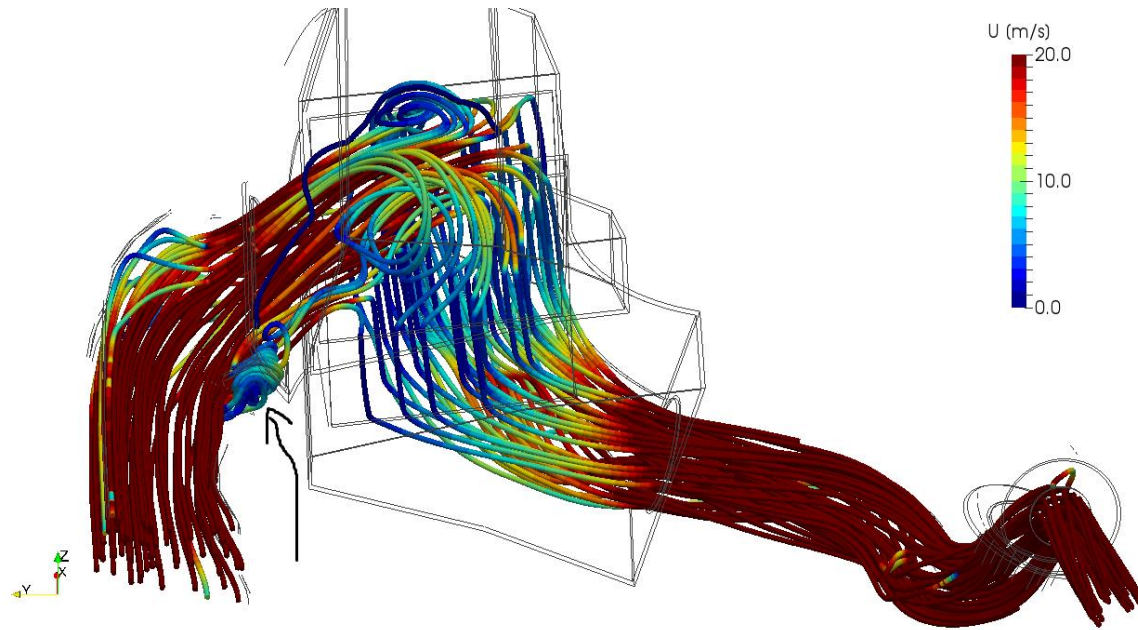
VW TDI – Benchmark (Skoda Octavia RS 2.0 TDI)



VW TSI – Benchmark (Skoda Octavia RS 2.0 TSI)



Check Your Results



Conclusion

- › HELYX-Adjoint easy to use
- › Experienced user → adjoint process shown 1-2 days
- › Pressure loss internal flows - well established process and method
- › Levelset topology engine works well, smooth results
- › Improvements in accuracy by future GLB topology engine
- › Fine tuning with shape optimisation