ADJOINT CFD FOR RAPID DESIGN OPTIMISATION

Cooperation with RevDop

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GOFUN 2019

27. February 2019

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CONTENTS

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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

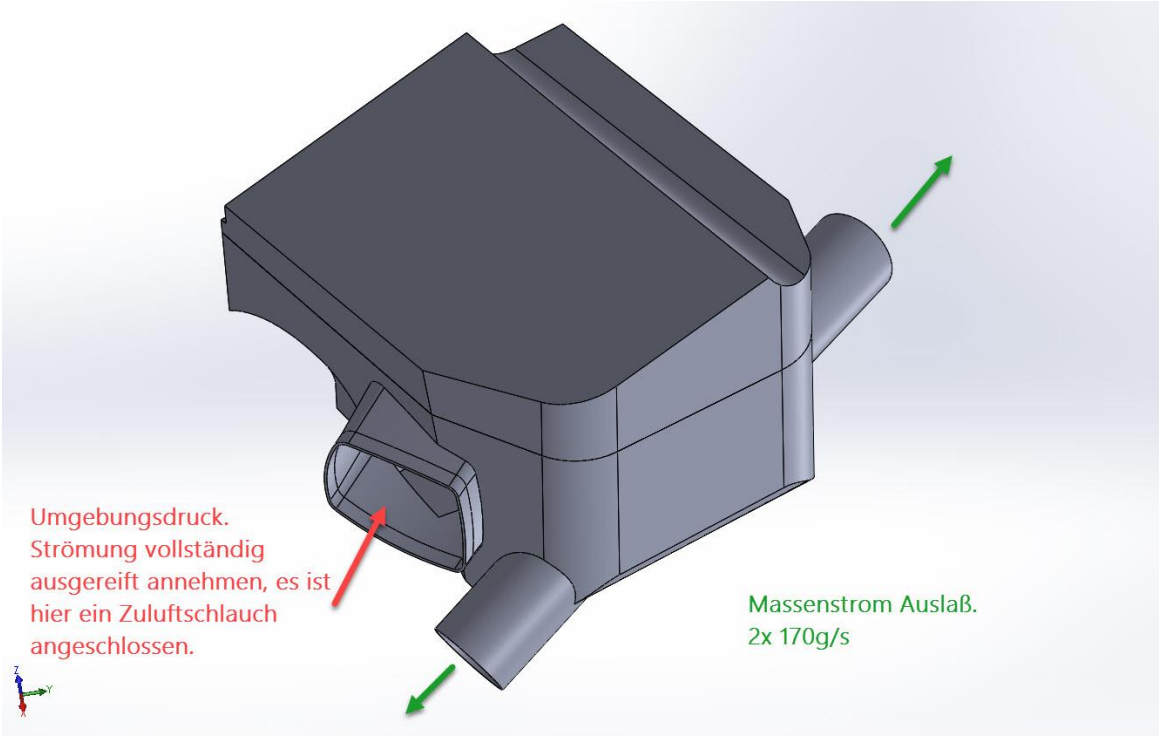
BMW N54 Airbox

- 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



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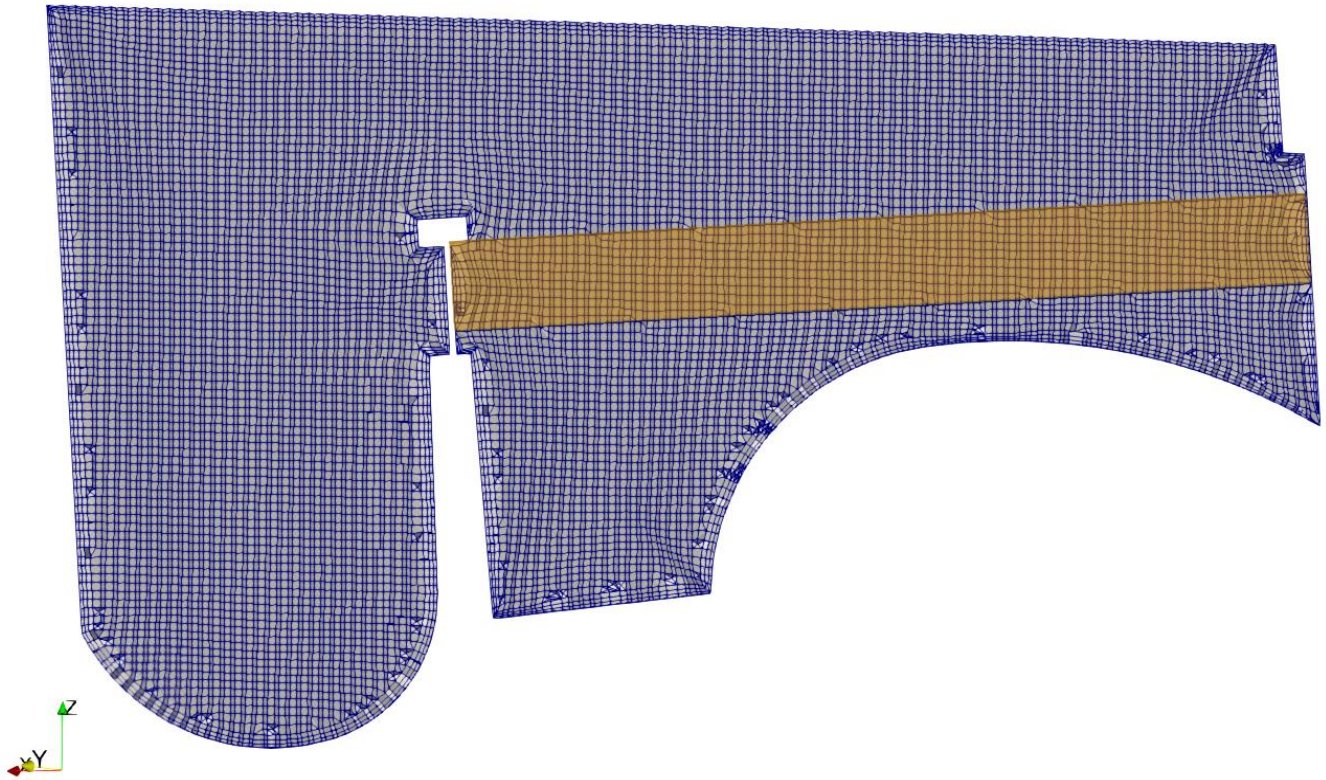
N54 Adjoint Setup

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



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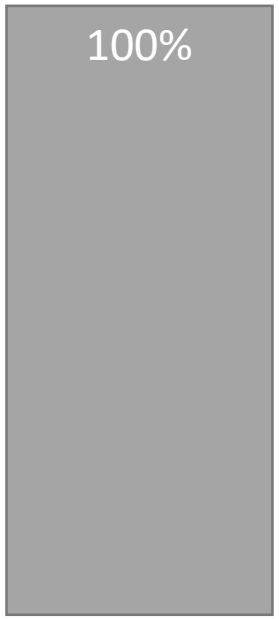
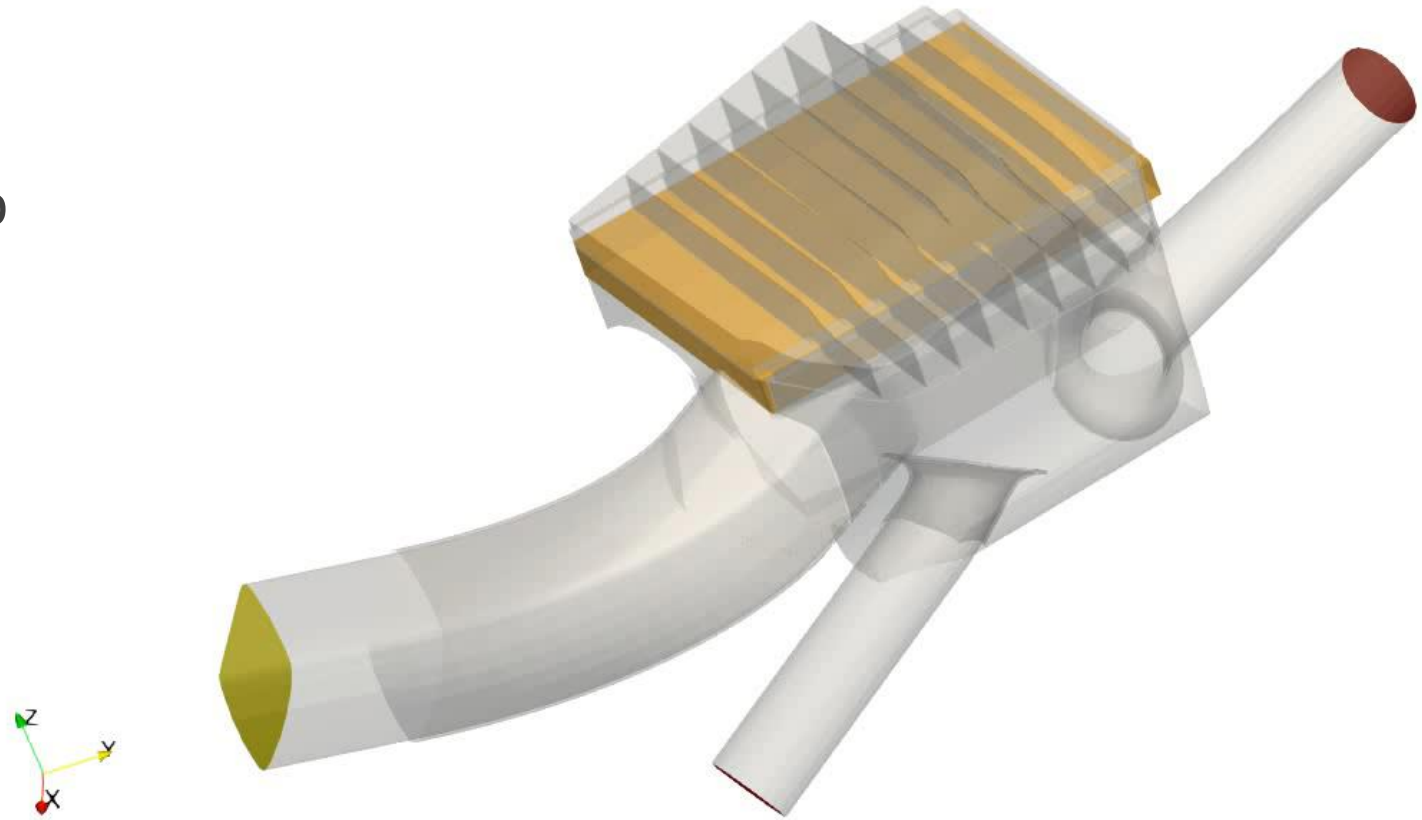
N54 Baseline

Pressure Drop





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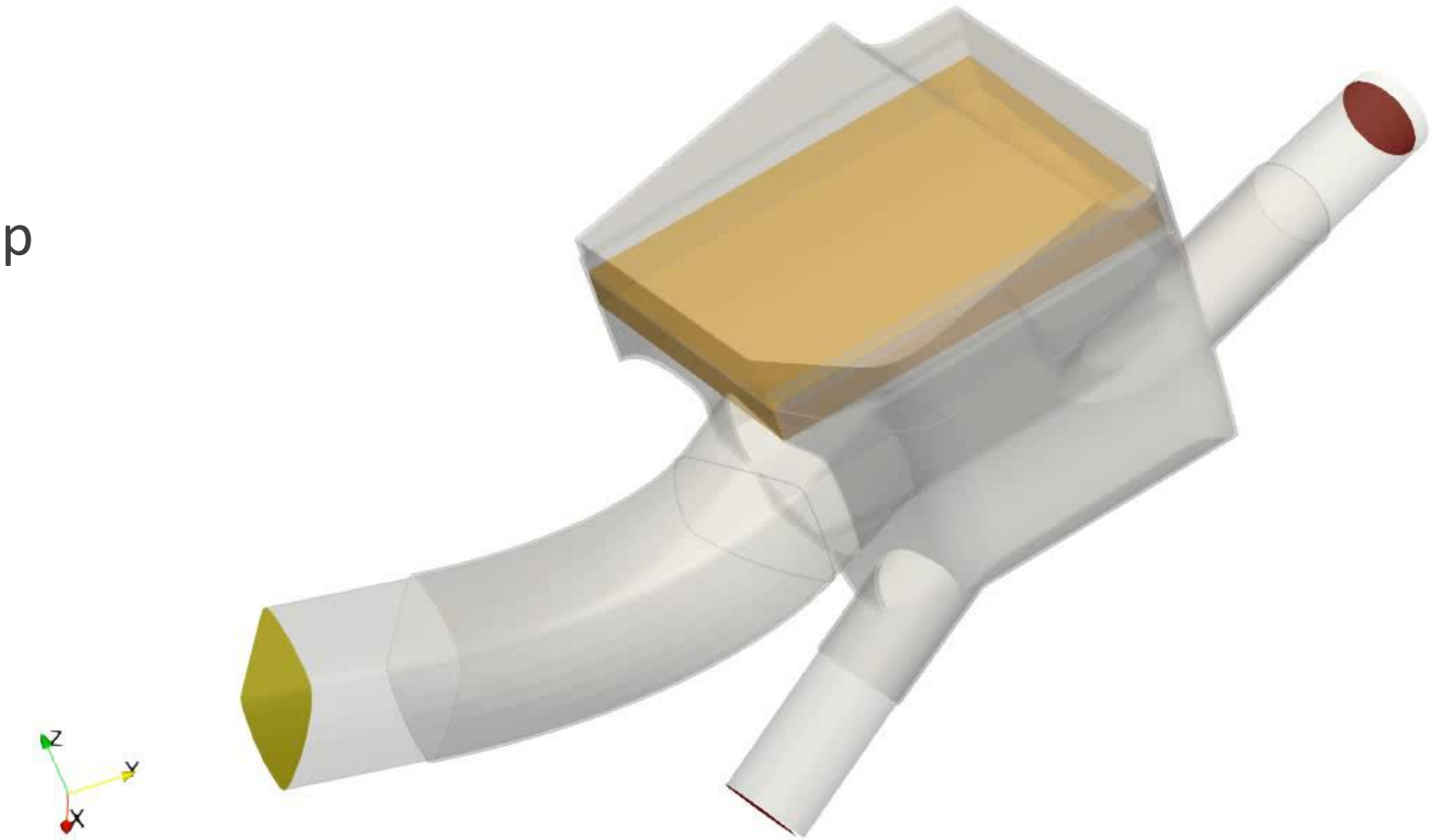
N54 Design Space

Pressure Drop

100%



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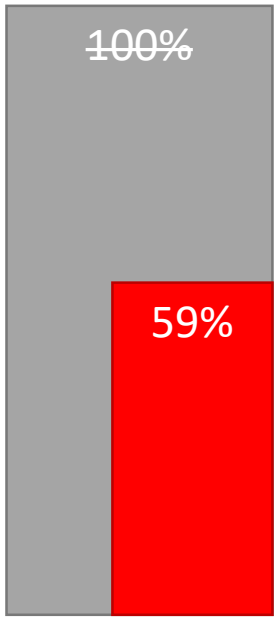
N54 Adjoint Design

Pressure Drop



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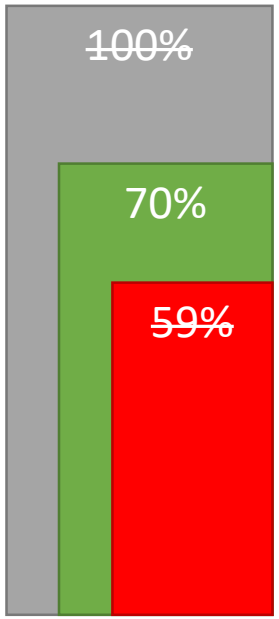
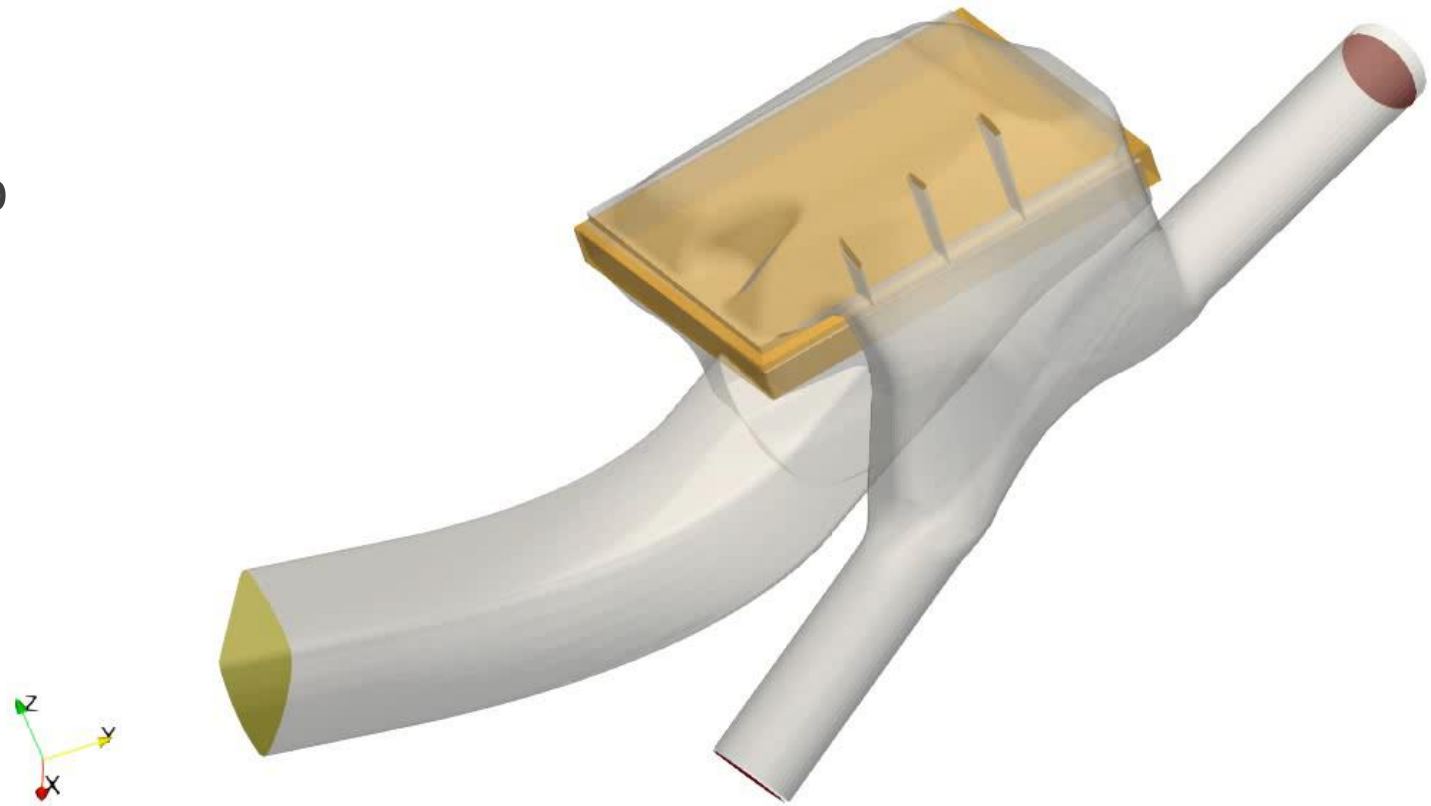
N54 Final Design – Manufacturing

Pressure Drop





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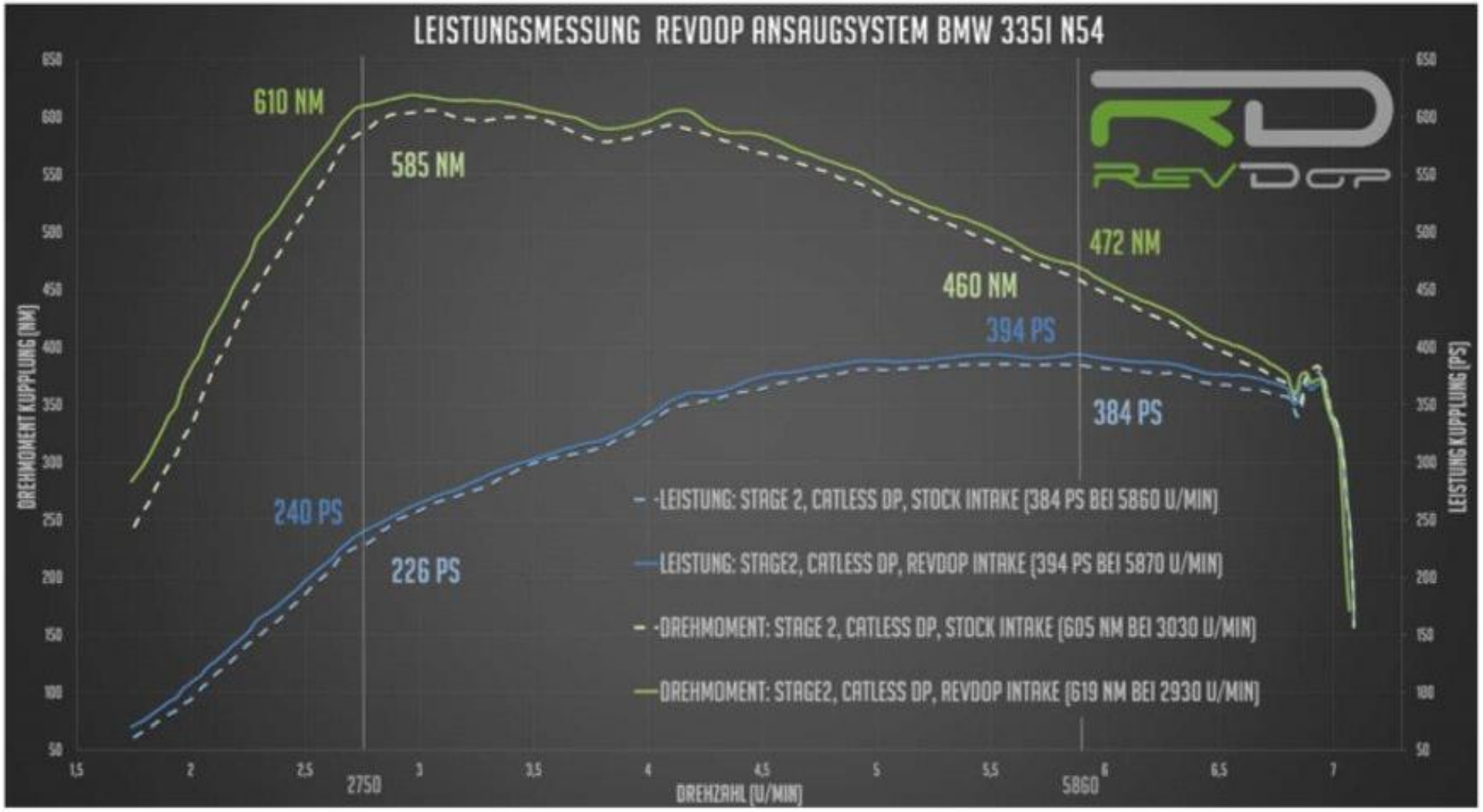
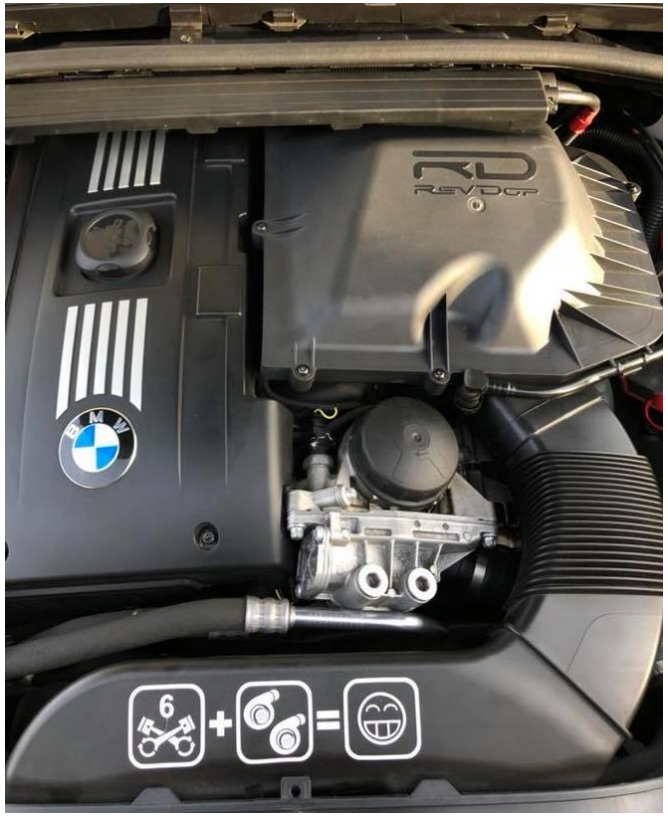
N54 Airbox Product

N54 Airbox Benchmark



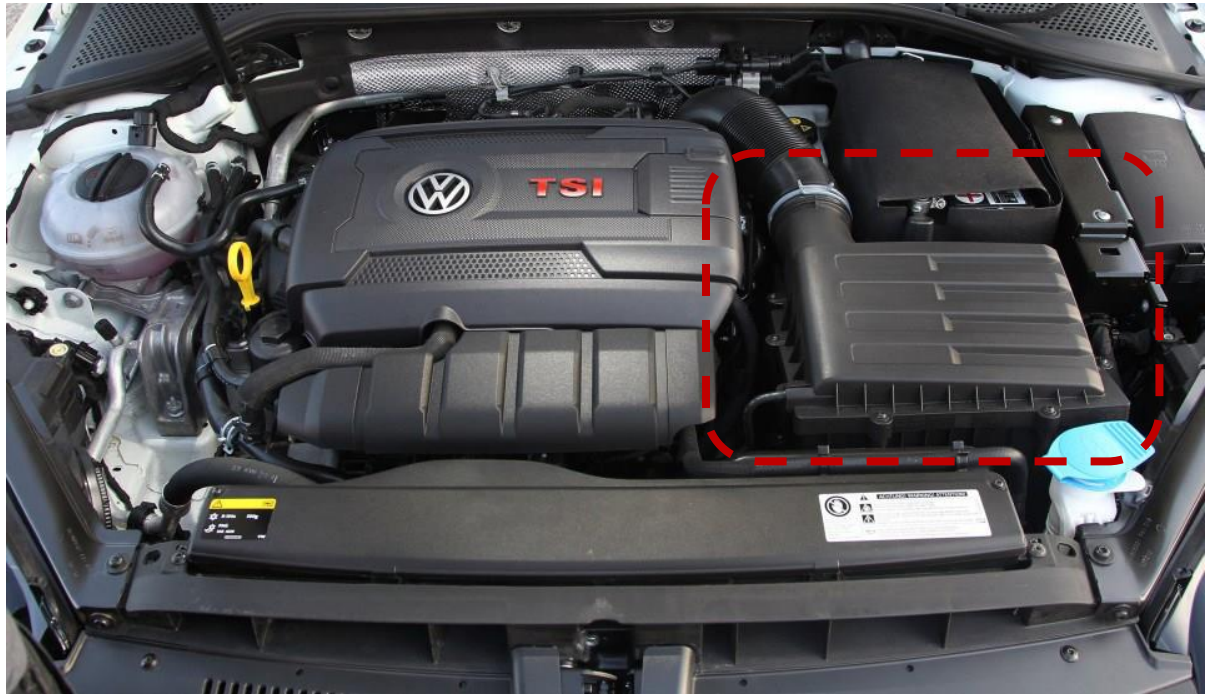
N54 Airbox Product

- 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



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VW TDI/TSI – Airbox

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

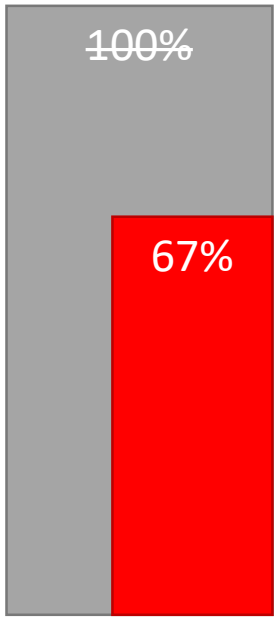
VW TDI/TSI – Baseline

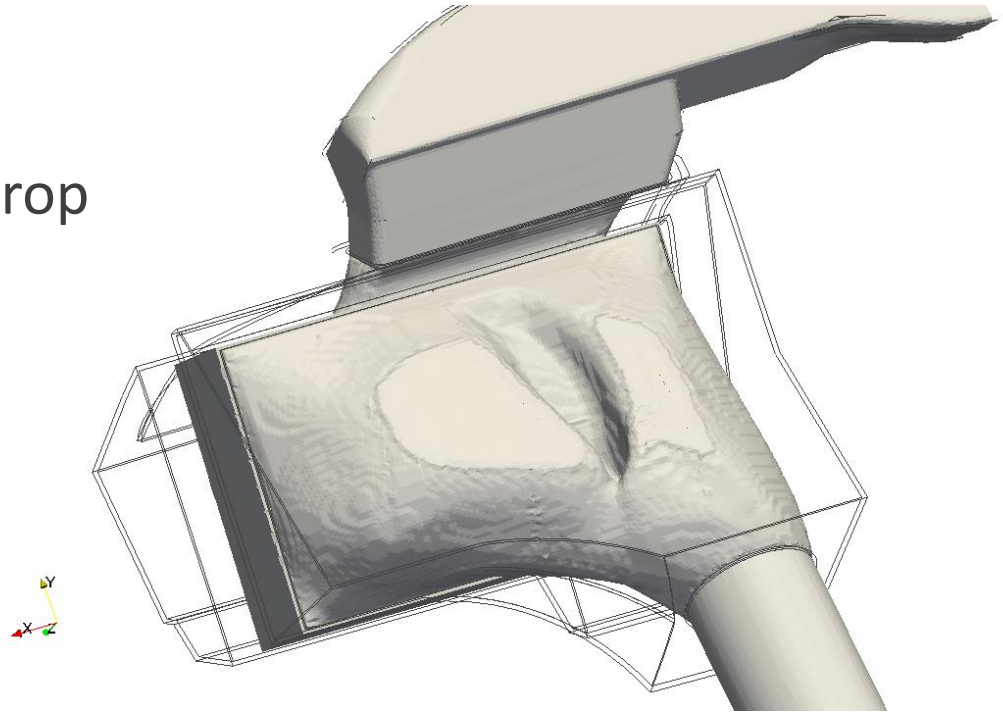
Pressure Drop

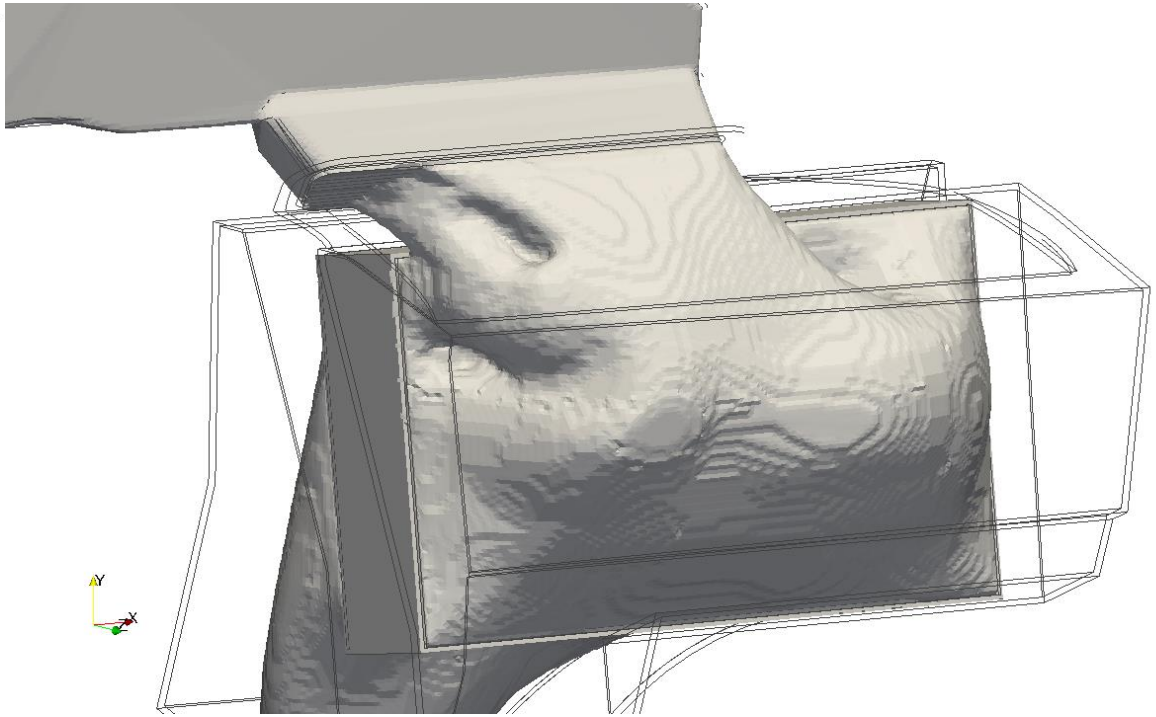
100%

VW TDI/TSI – Design Space & Adjoint

Pressure Drop







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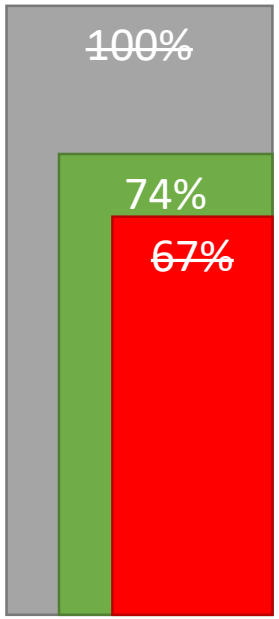
VW TDI/TSI – Final Design

Pressure Drop



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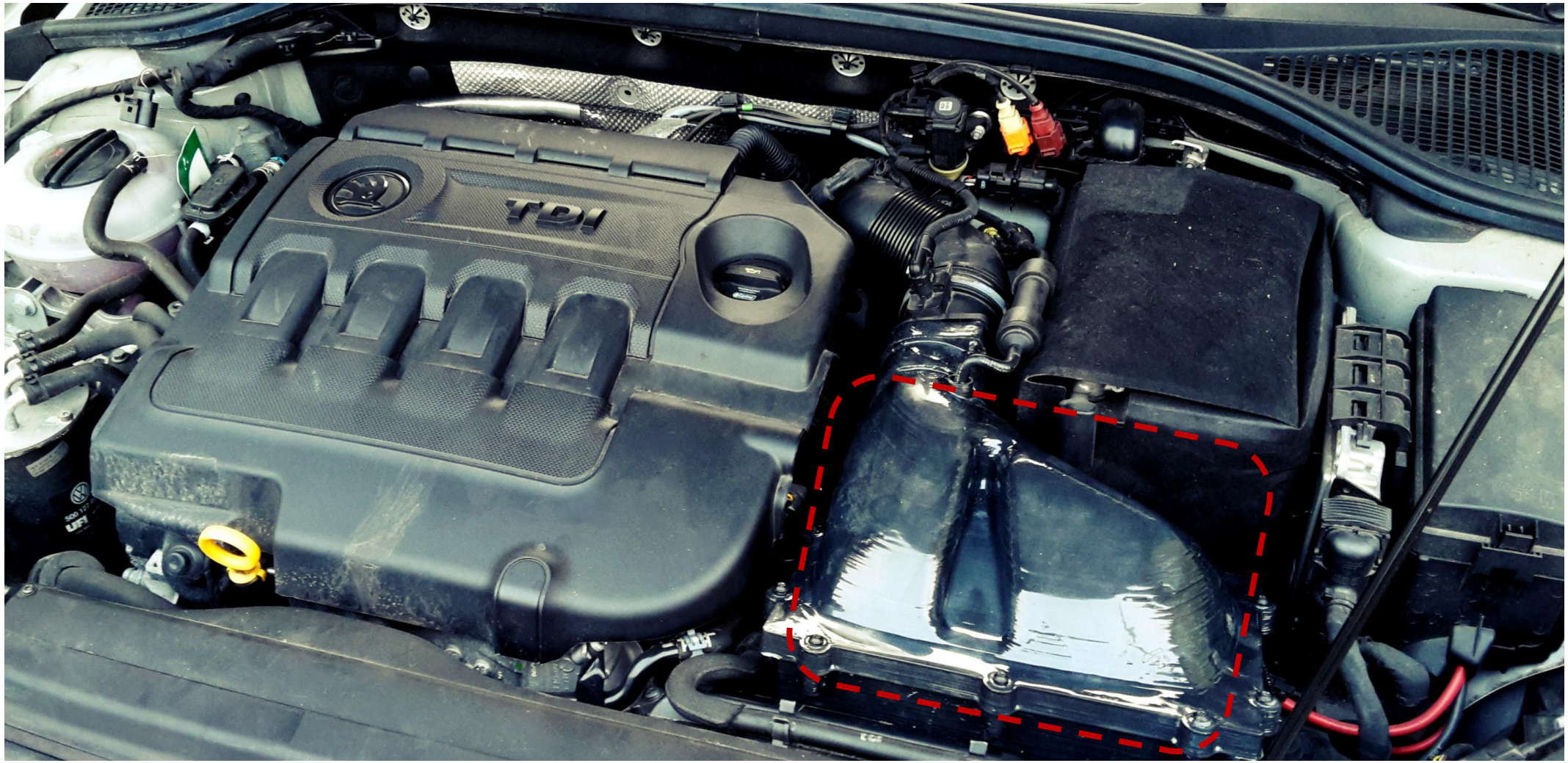
VW TDI/TSI – Benchmark



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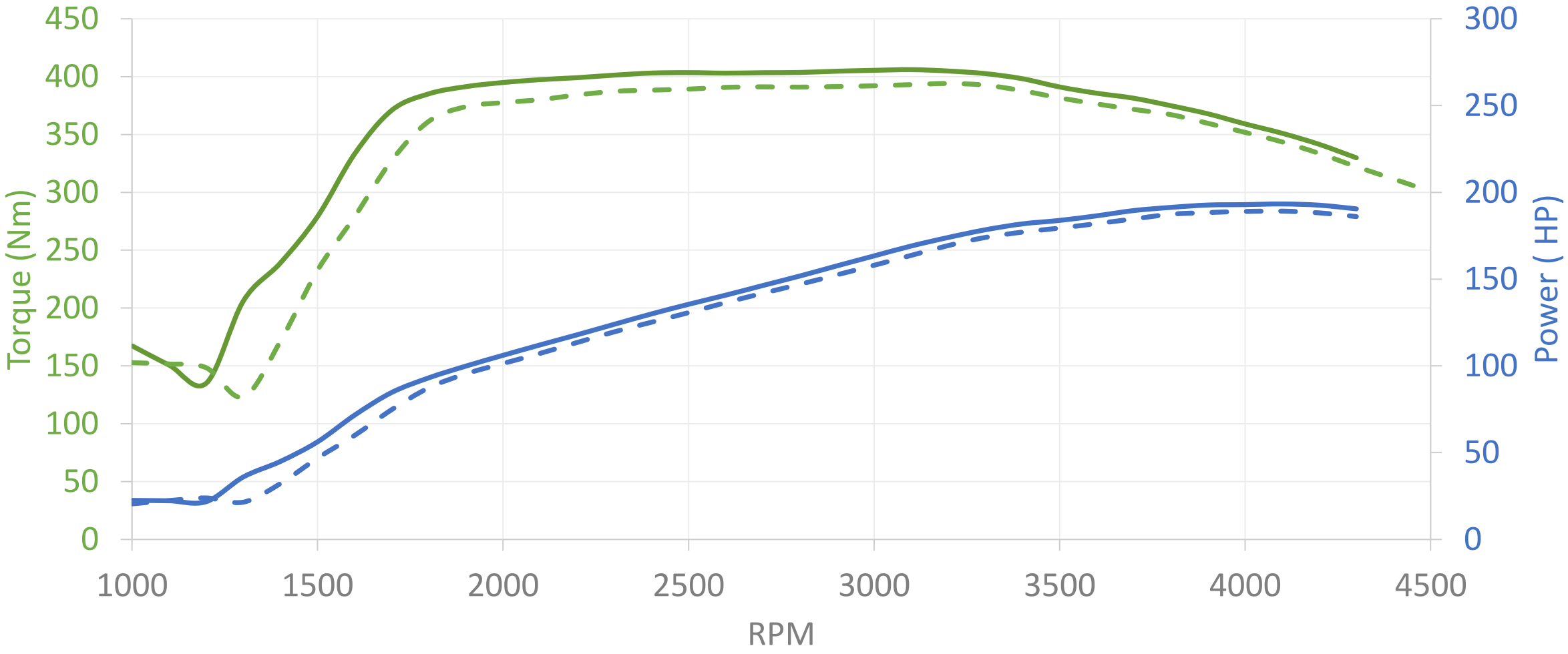
VW TDI – Benchmark (Skoda Octavia RS 2.0 TDI)



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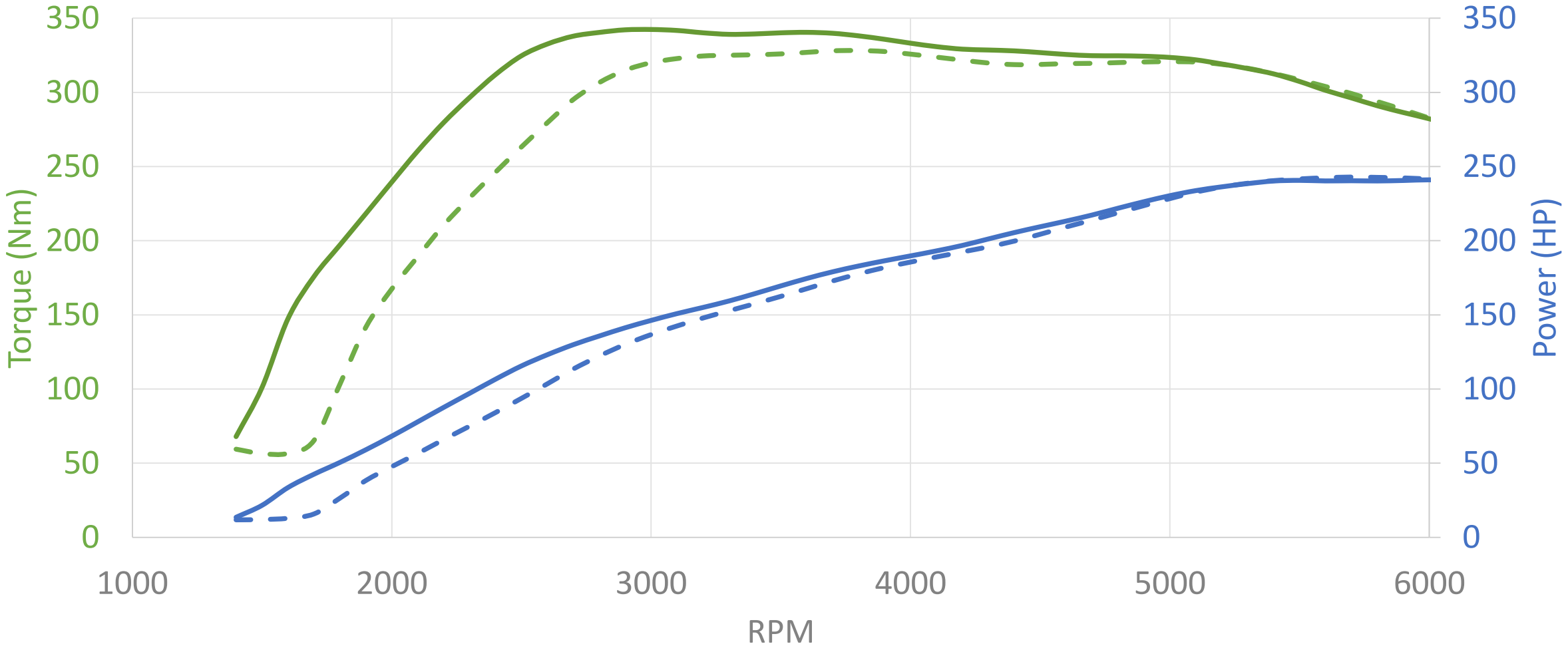
VW TSI – Benchmark (Skoda Octavia RS 2.0 TSI)



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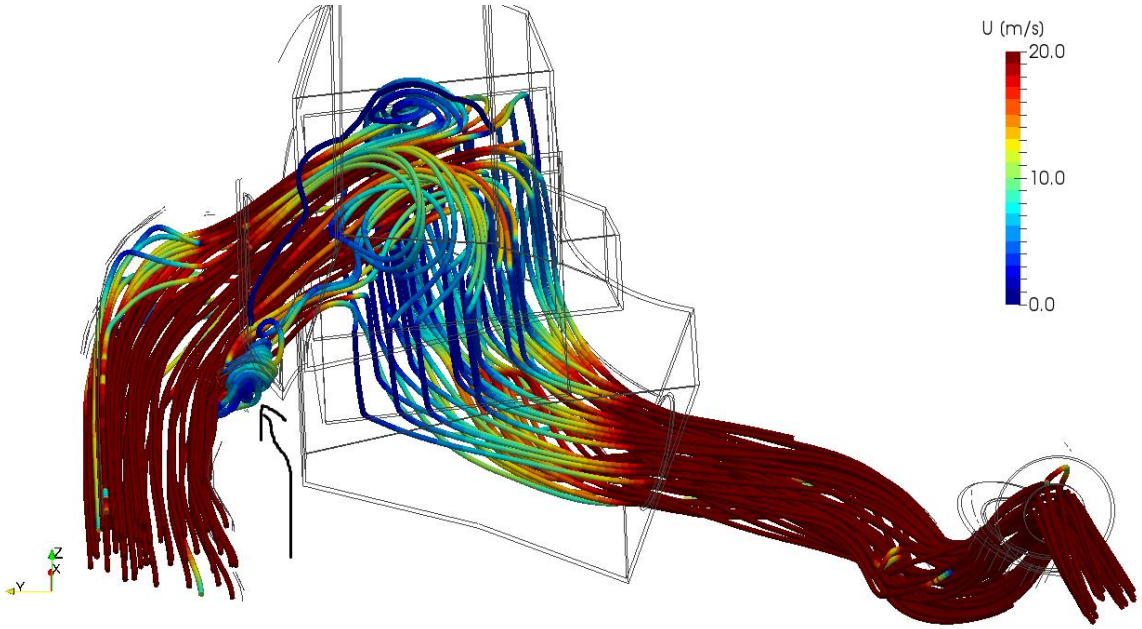
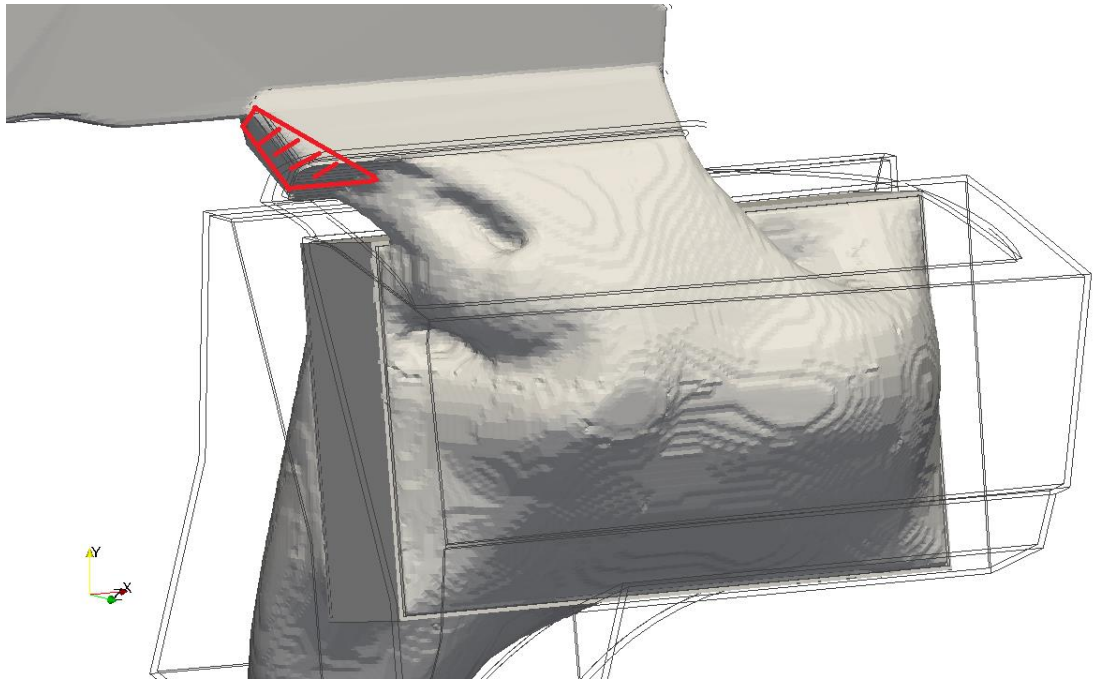
Check Your Results





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 GIB topology engine
- Fine tuning with shape optimisation