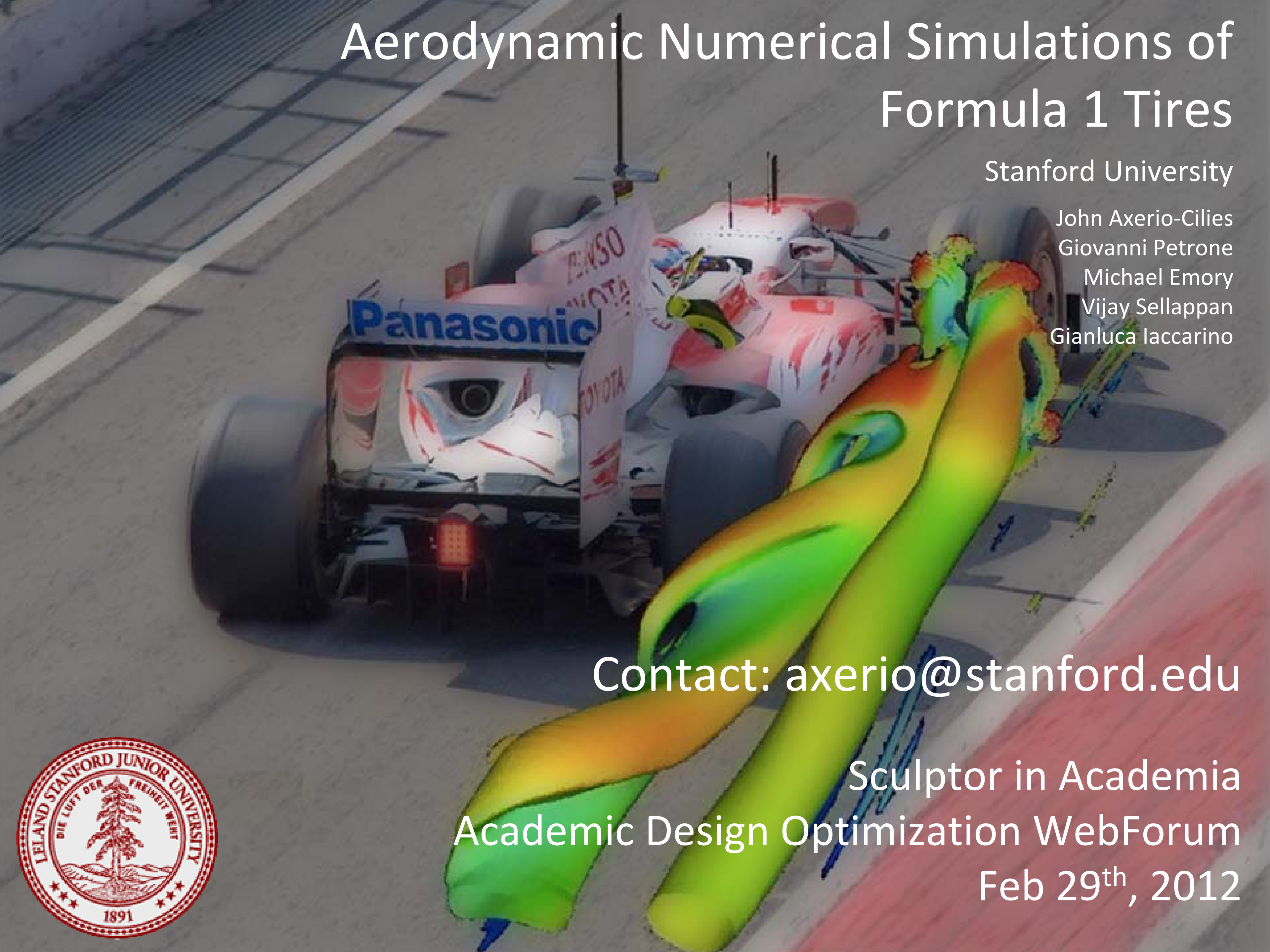

Aerodynamic Numerical Simulations of Formula 1 Tires

Stanford University

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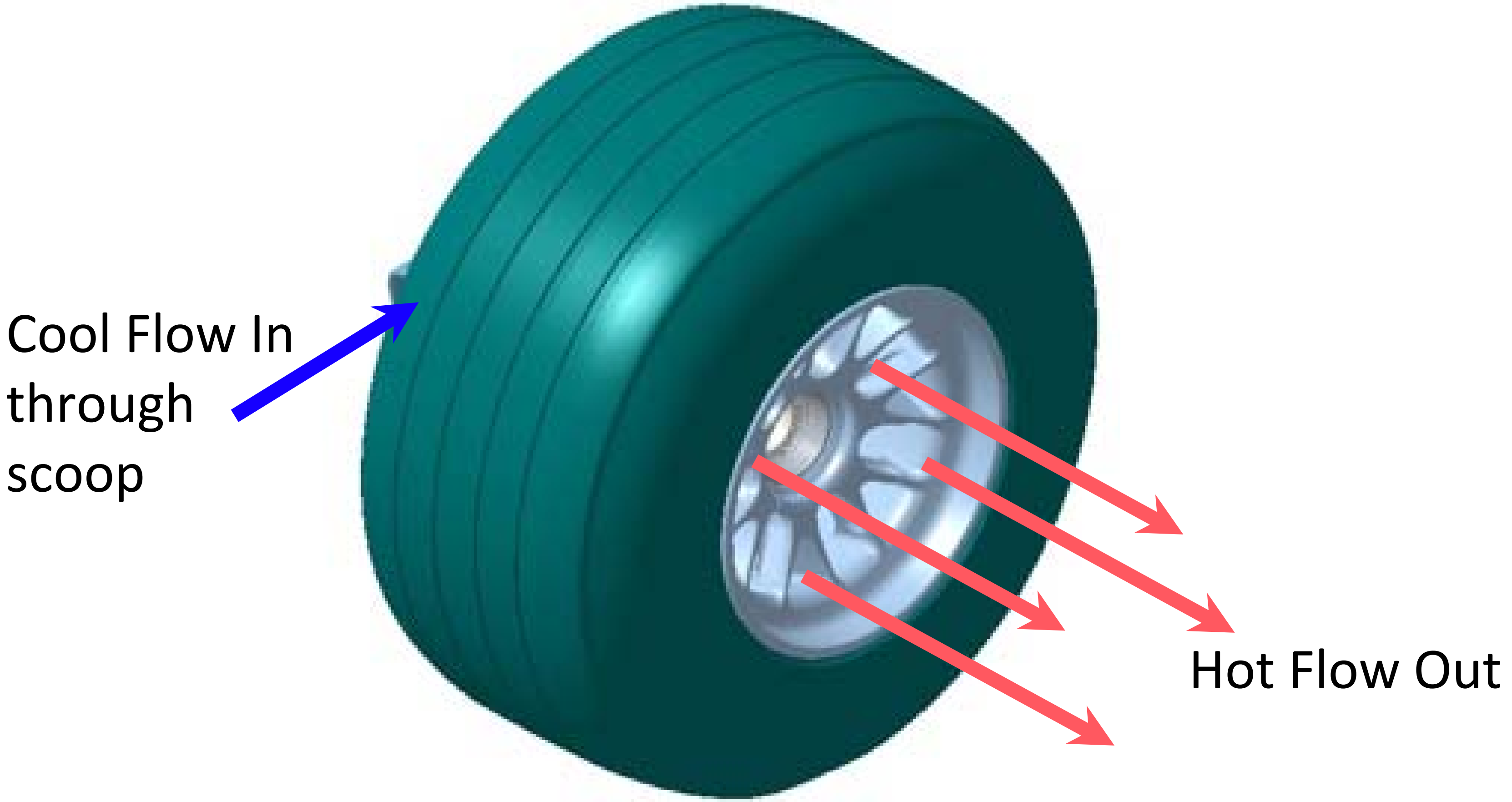
Sculptor in Academia
Academic Design Optimization WebForum
Feb 29th, 2012

Stanford Resources

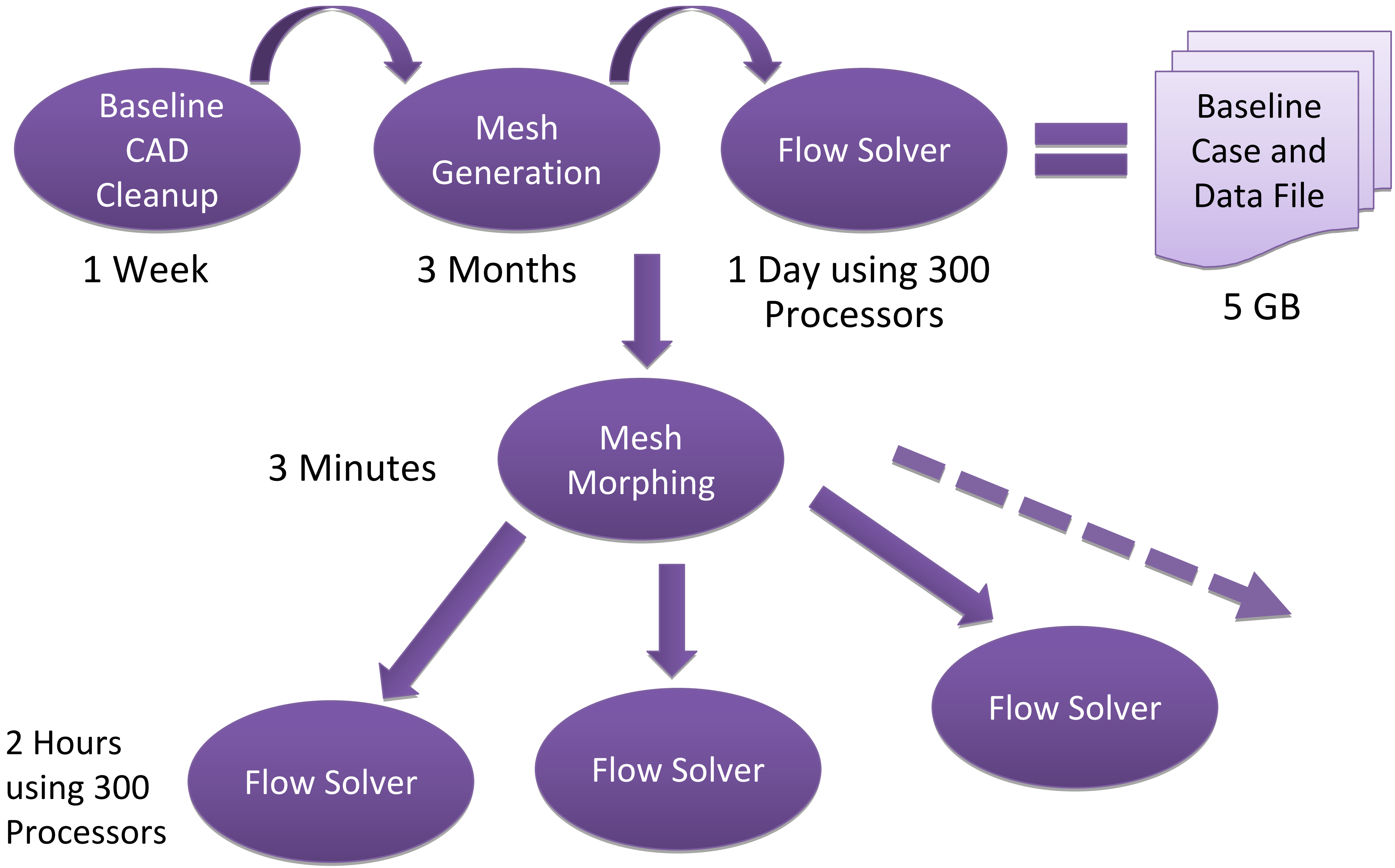
- 5 groups in ME @ Stanford
- Thermal & Fluid Sciences Affiliates Program (tfsa.stanford.edu)
  - Contact: Prof. Gianluca Iaccarino (jops@stanford.edu)
- HPC resources at Stanford: 12 clusters, largest cluster (Certainty) has ~ 6500 compute cores

Application Overarching Goal

- Improve the cooling brake duct design by increasing performance in presence of uncertainty
- Determine trade-off between maximizing mass flow rate through brake duct while minimizing drag

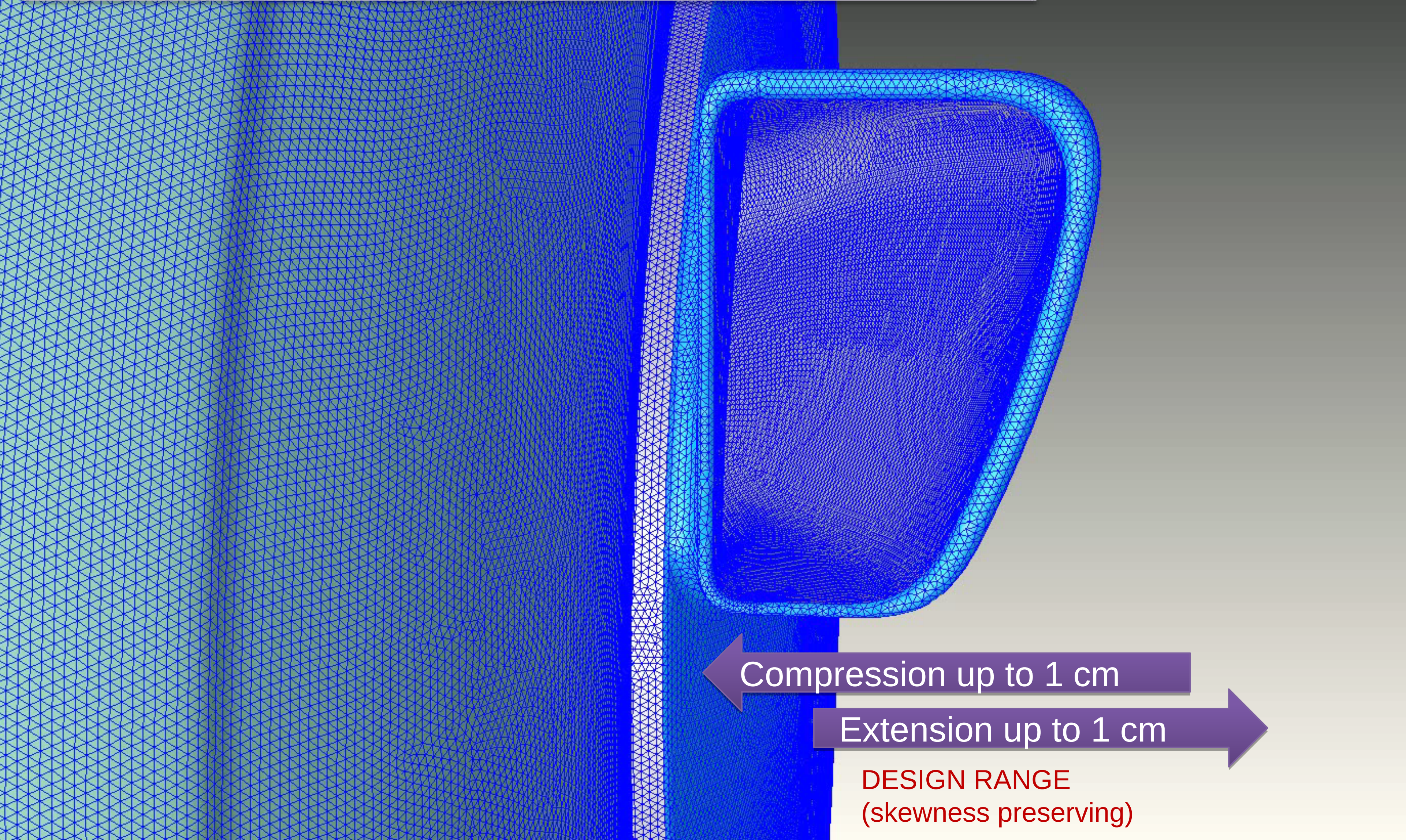


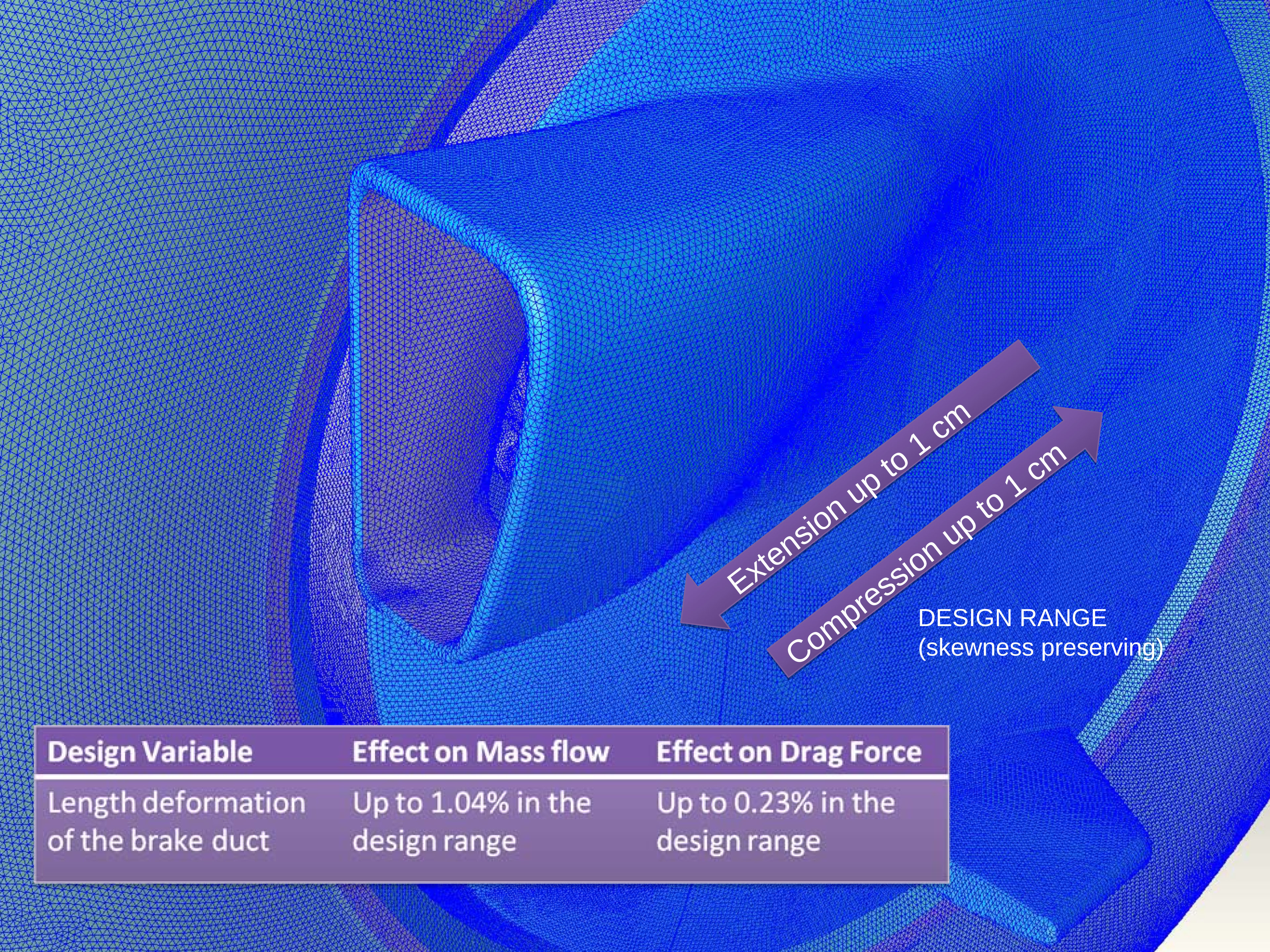
Computational Infrastructure



Baseline mesh has approximately 30 million cells

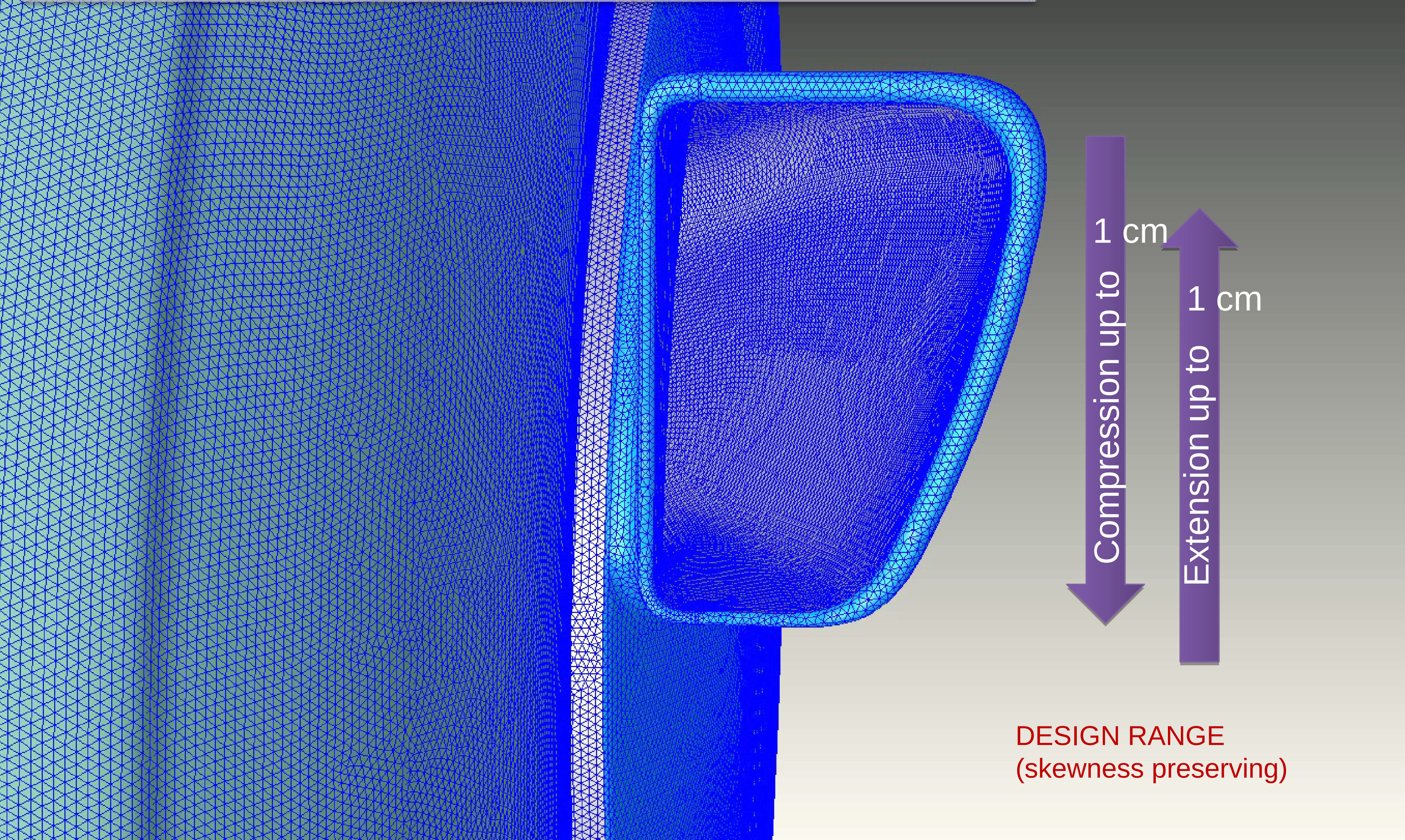
Design Variable	Effect on Mass flow	Effect on Drag Force
Top deformation of the brake duct	Up to 20.6% in the design range	Up to 1.9% in the design range





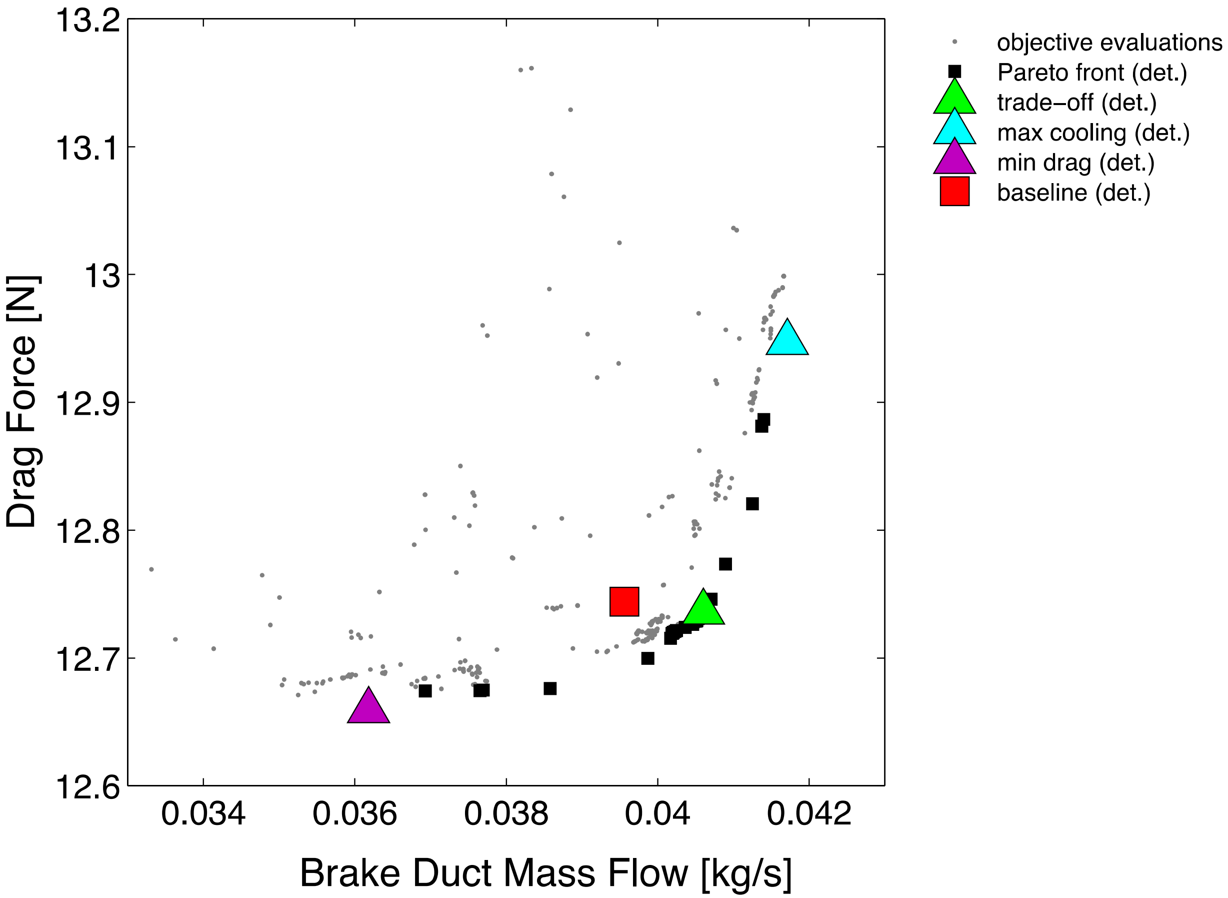
Design Variable	Effect on Mass flow	Effect on Drag Force
Length deformation of the brake duct	Up to 1.04% in the design range	Up to 0.23% in the design range

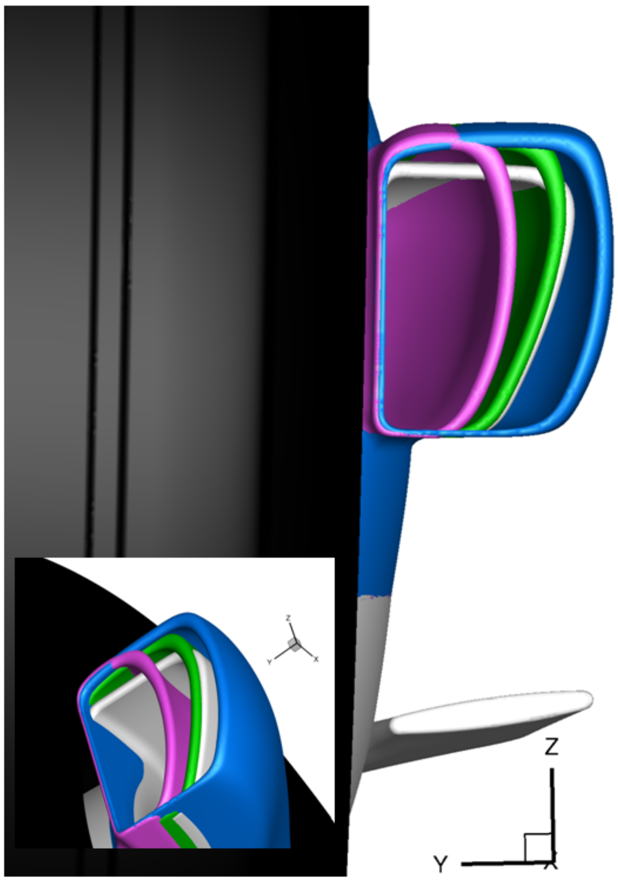
Design Variable	Effect on Mass flow	Effect on Drag Force
Side deformation of the brake duct	Up to 9.1% in the design range	Up to 0.86% in the design range

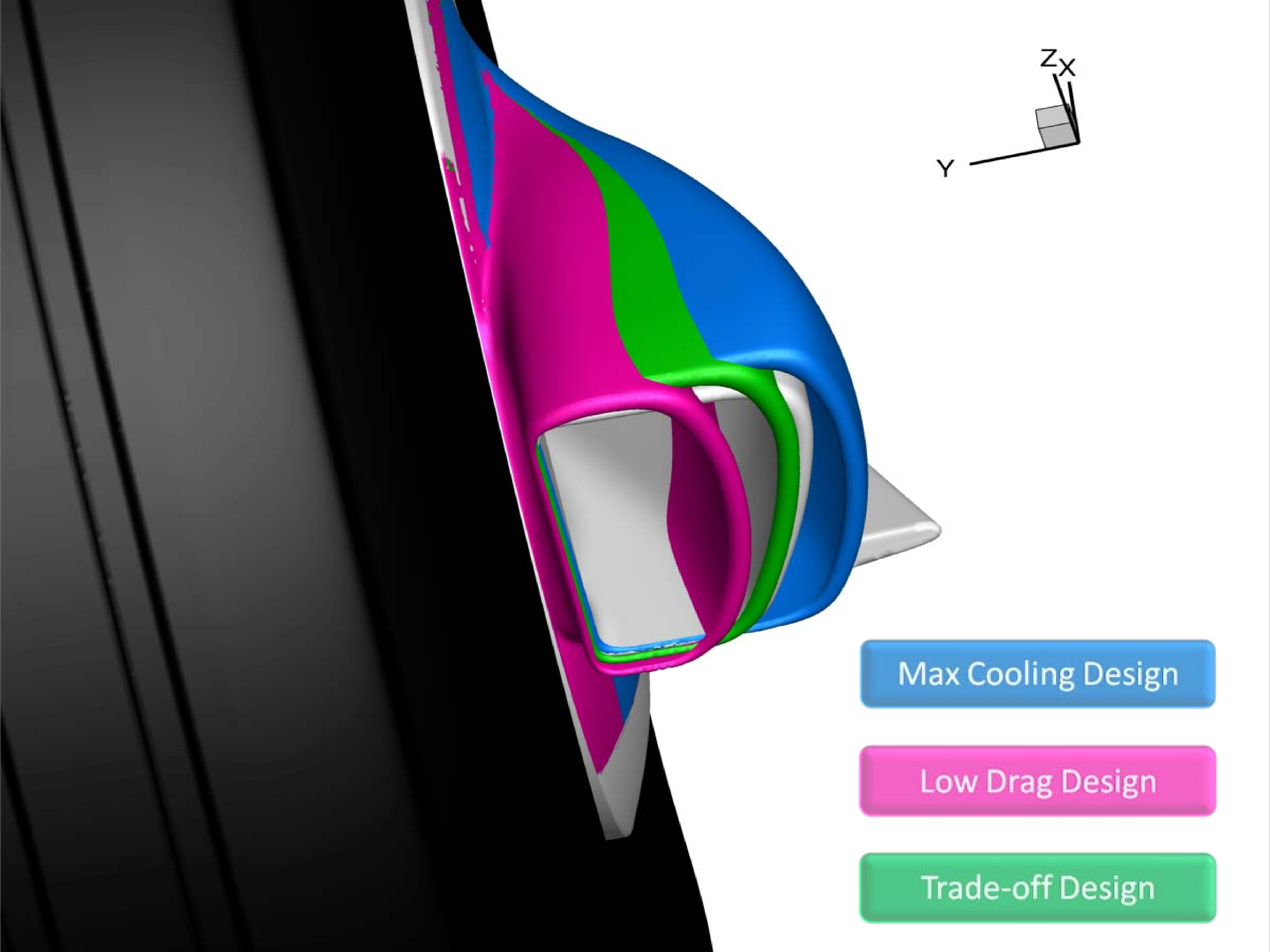


Deterministic Pareto Front

Multi-objective Optimization Strategy: NSGA-II






Z
X
Y
Max Cooling Design
Low Drag Design
Trade-off Design

Conclusions

- Used Sculptor in batch to morph geometry locally
- DoE approach to find sensitivity of design variables
- Determined trade off design for multi-objective optimization