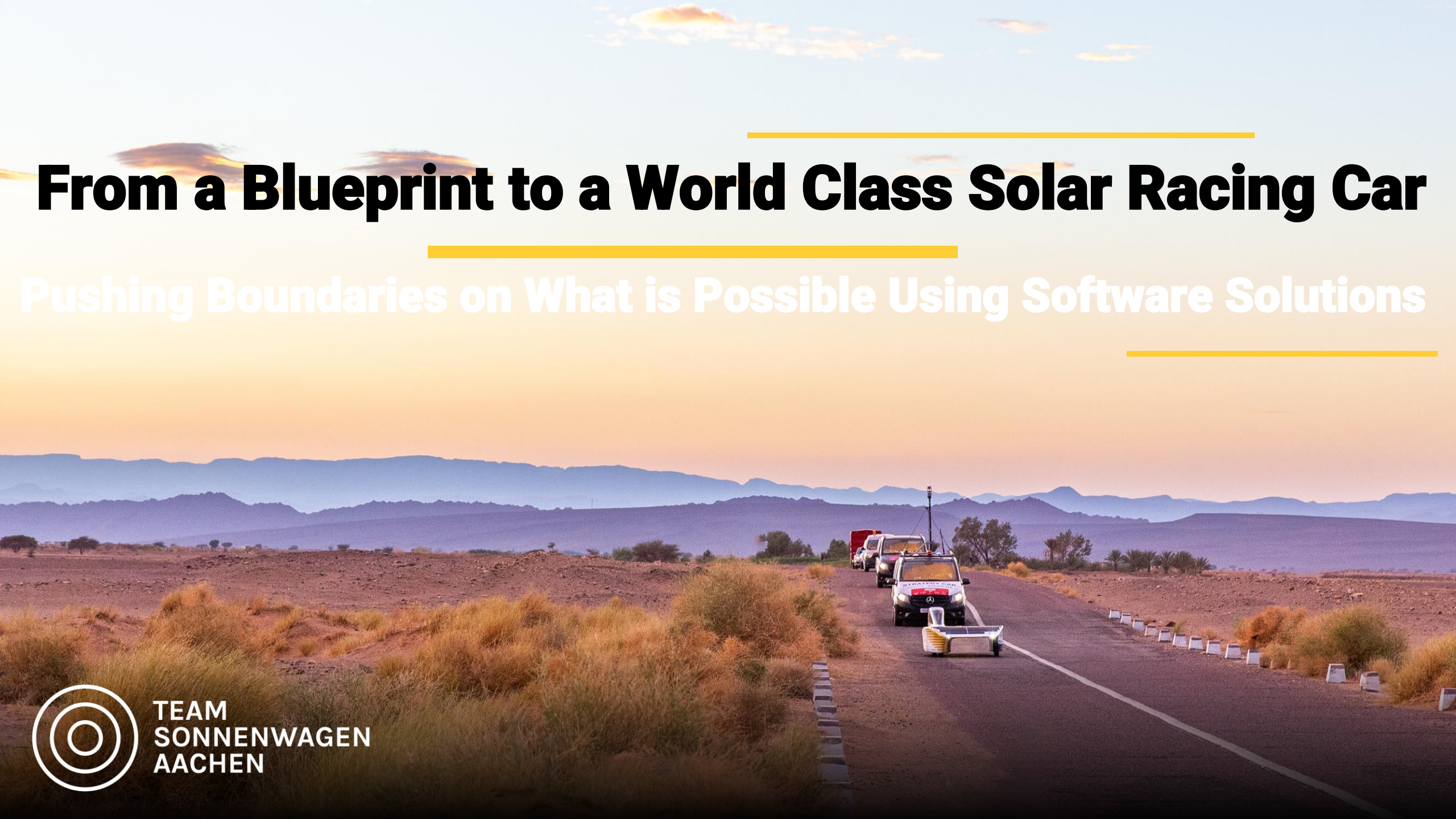


From a Blueprint to a World Class Solar Racing Car

Pushing Boundaries on What is Possible Using Software Solutions



TEAM
SONNENWAGEN
AACHEN



Project Overview

OUR DEPARTMENTS



Chassis



Aerodynamics



Structure



Electrical Engineering



Driving Strategy



Manufacturing



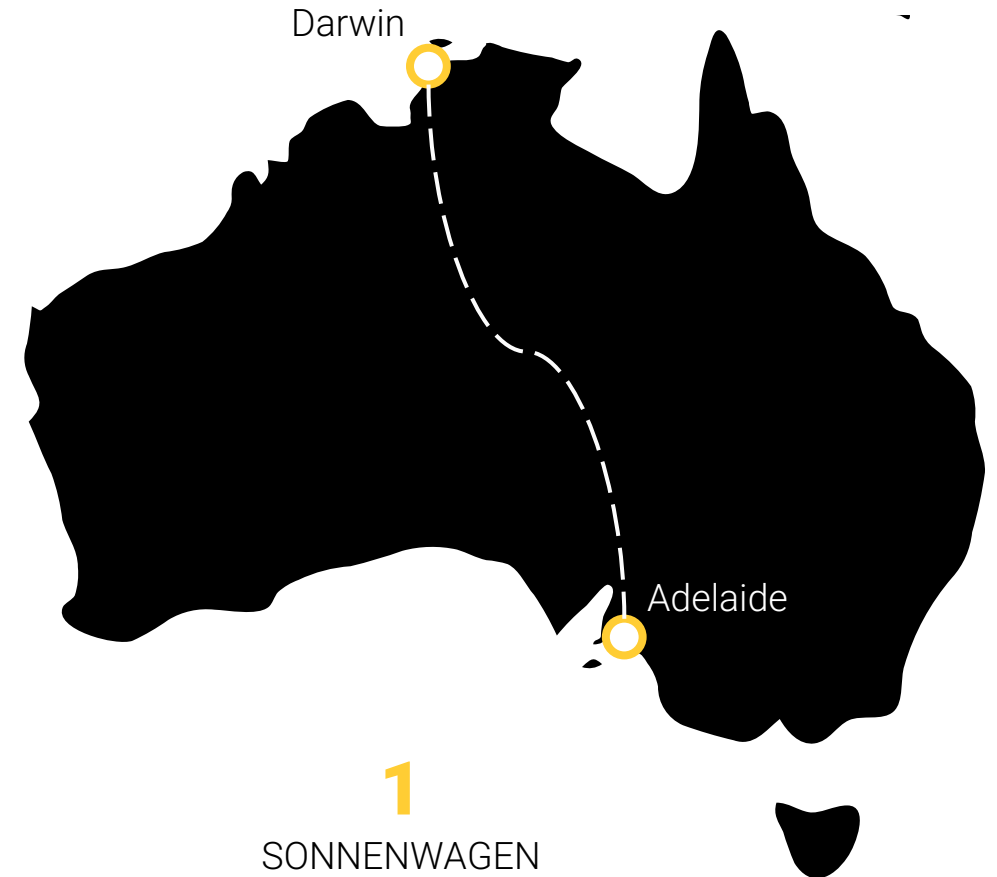
Sponsoring



Marketing



Logistics



1

SONNENWAGEN

5

DAYS OF RACING TIME

3022 KM

ACROSS THE AUSTRALIAN OUTBACK



We are More Than Just a Racing Team

STUDENT TEAM

- Founded 2015 in Aachen
- 50 RWTH Aachen and FH Aachen students
- Aspiring engineers and researchers with the aim to reach and break through the known limits of what is possible



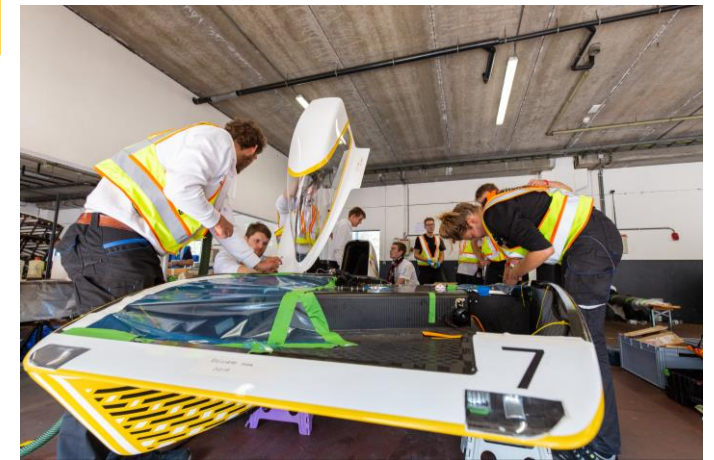
SUSTAINABLE MOBILITY



- 3022 km through Australia, only powered by solar energy in October 2023
- Testing under extreme conditions in the Australian outback
- Participation in many international racing events

FUTURE TECHNOLOGY

- Close cooperation with universities in technology oriented research projects
- Joint development and testing of innovations with industrial partners



Our Challenges

EUROPEAN SOLAR CHALLENGE

- Circuit Zolder, Belgium
- Fastest Lap for Qualification
- 24h race
- Two charging stops allowed



ITALIAN SOLAR CHALLENGE



- Autodromo di Imola, Italy
- First solar race in Italy
- Challenging track due to steep inclines
- Tech Talk

WORLD SOLAR CHALLENGE

- 3022 km, straight through the Australian Outback
- 5-7 days
- 50 teams, from known universities
- 24 countries
- Main challenge → Regulations



Our Achievements

SONNENWAGEN 1

World Solar Challenge 2017

- Made it to the finish line
- Top speed of 138 km/h (86 mph)
- Awarded as the best newcomer



COVESTRO SONNENWAGEN

World Solar Challenge 2019

- 6th Place
- Awarded David Fewchuck Spirit of the Event Award
- Awarded Events Safety Award

European Solar Challenge 2021 and 2022

- 2nd Place



Our Achievements

COVESTRO PHOTON

Solar Challenge Morocco 2021

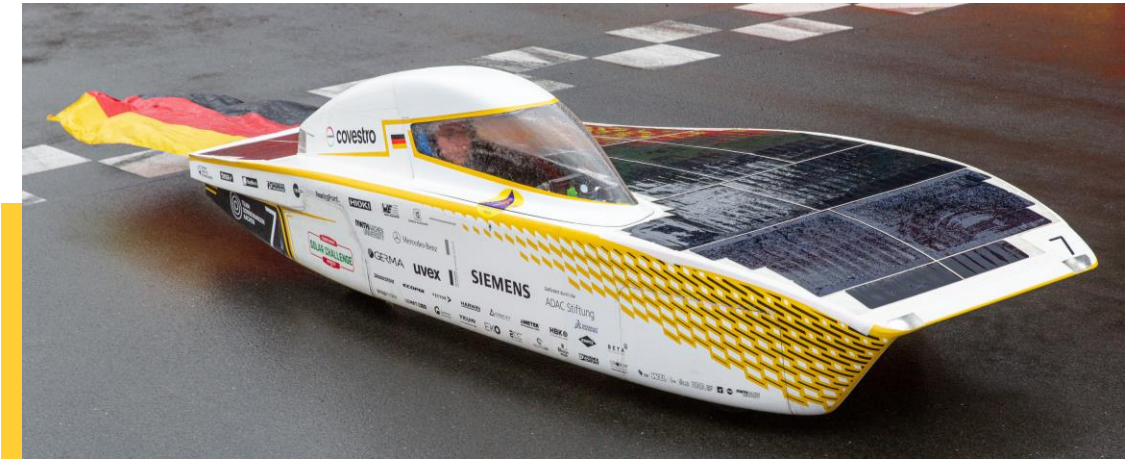
- 5th Place
- Awarded spirit of the event award

European Solar Challenge 2022

- 1st Place

Italian Solar Challenge 2022

- 1st Place



GOALS FOR OUR NEW SONNENWAGEN

- Build the worlds **most efficient** solar car
- Win the World Solar Challenge 2023



Covestro Photon 2021



SOLAR CELLS

4 m² monocrystalline silicon solar cells



STRUCTURE

Ultra-light vehicle made of carbon fiber composites



ENGINE

Self-developed wheel hub motor with >96% overall efficiency



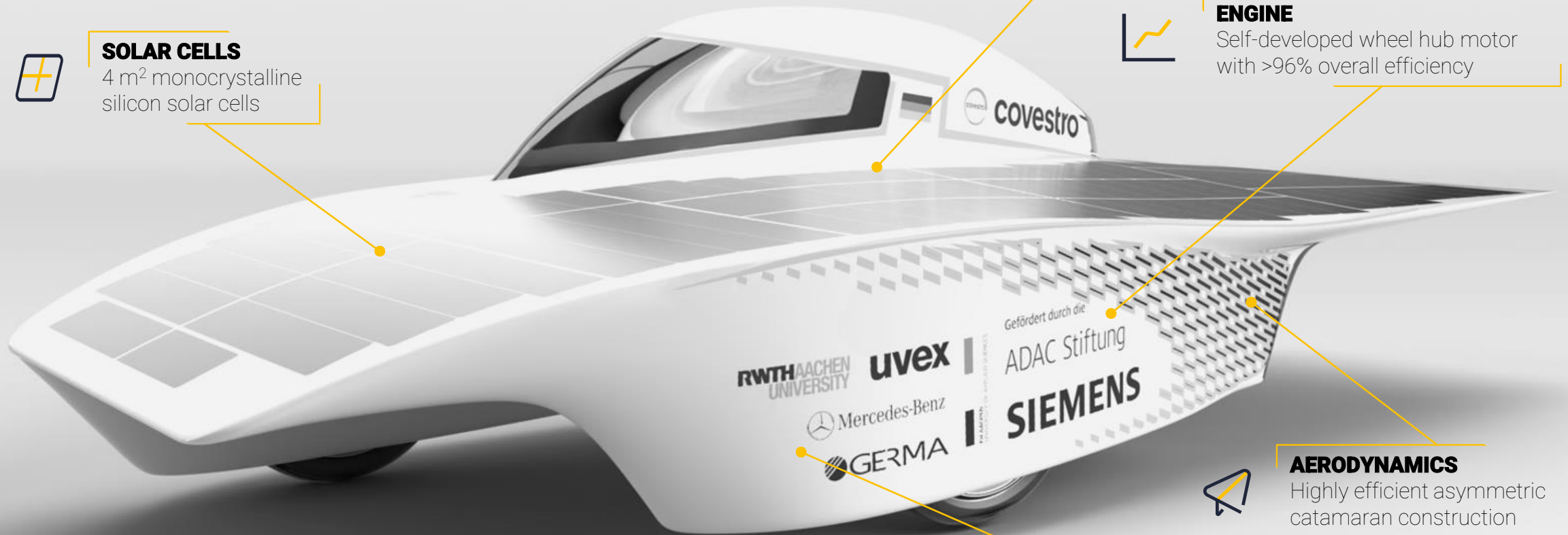
AERODYNAMICS

Highly efficient asymmetric catamaran construction



BATTERY

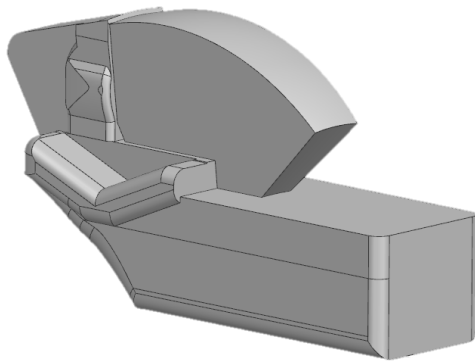
> 6 kWh battery consisting of lithium iron phosphate cells



World Solar Challenge: Regulations and Goals

REGULATIONS

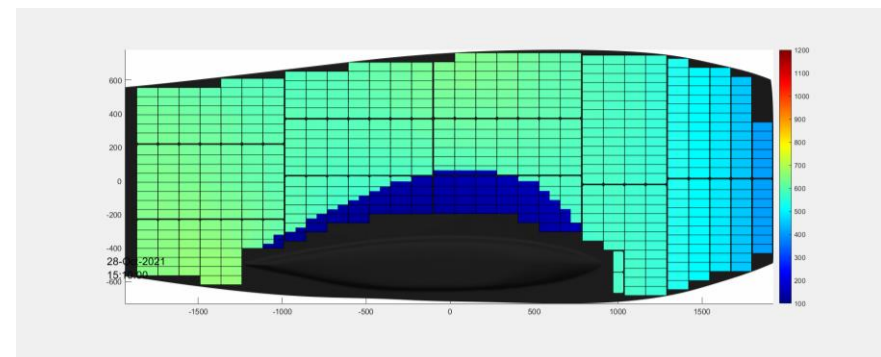
- One driver ~ 80 kg
- At least **3 wheels**
- Solar array area is limited to **4 m²**
- LFP cell weight is limited to ~ 40 kg
- Predefined driver cell



Predefined drivers cell for the World Solar Challenge

DEVELOPMENT GOALS

- Maximise usable energy
 - Avoiding any kind of shadow
 - Maximising battery capacity
- Minimise cumulative resistances
 - Energy usage while driving at 90 km/h ~ 1kW (56 mph)



Power input of the solar array during a raceday

Wide Range of Possibilities

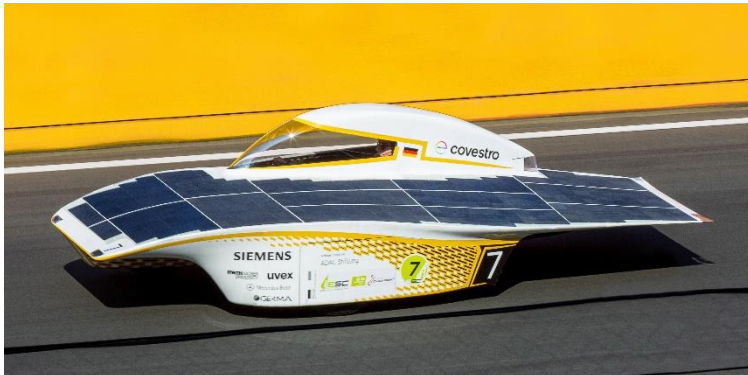
- 3 vs. 4 wheels
- Basic concept
 - Arrow
 - Catamaran
 - Trimaran
- **Symmetrical** or **asymmetrical** design
 - Cockpit position
- Limited **development time**
 - **Less than two years** between the start of design and the race



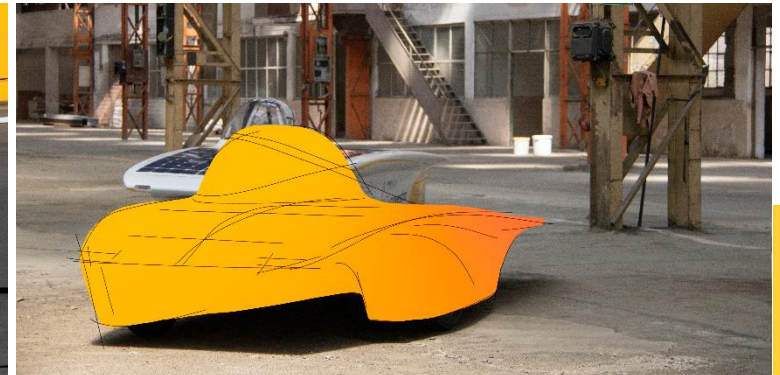
Sonnenwagen 1; 2017



Covestro Sonnenwagen; 2019



Covestro Photon; 2021

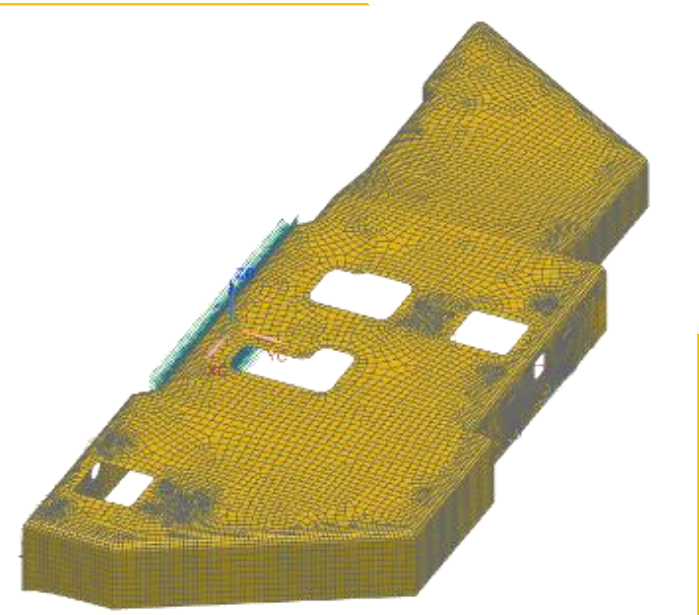


Sonnenwagen 4; (5th of June 2023)

Vehicle Design, Simulation and Testing



Aerodynamic Design



Simulation of Monocoque

Limited Space



Safety

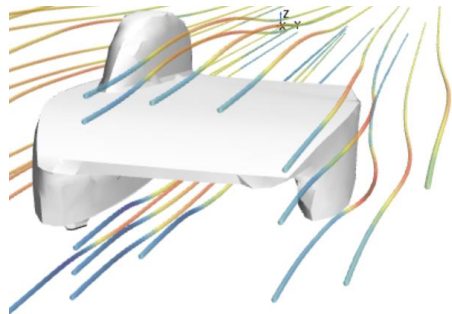
Lightweight



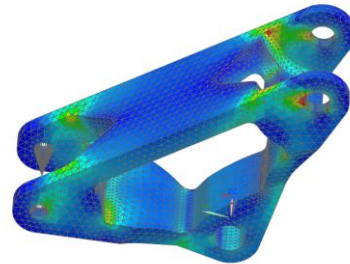
Material Testing

Data-Driven Design

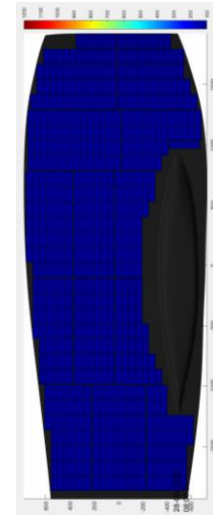
 **Aerodynamic Concept**



 **Mechanical Validation**



 **Electric Analysis**

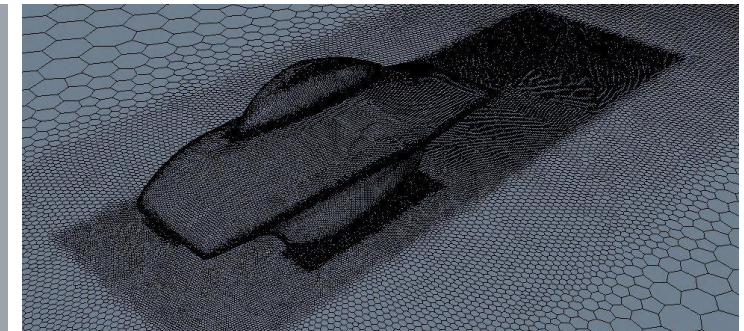
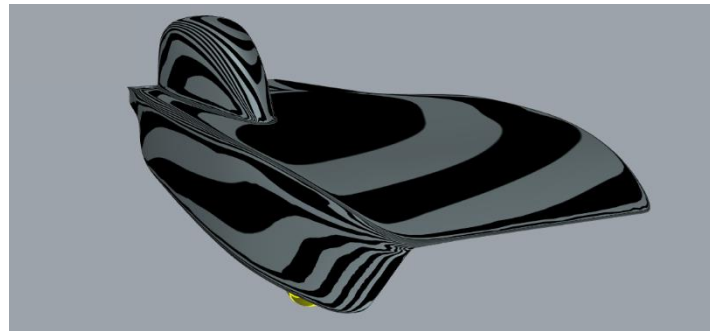
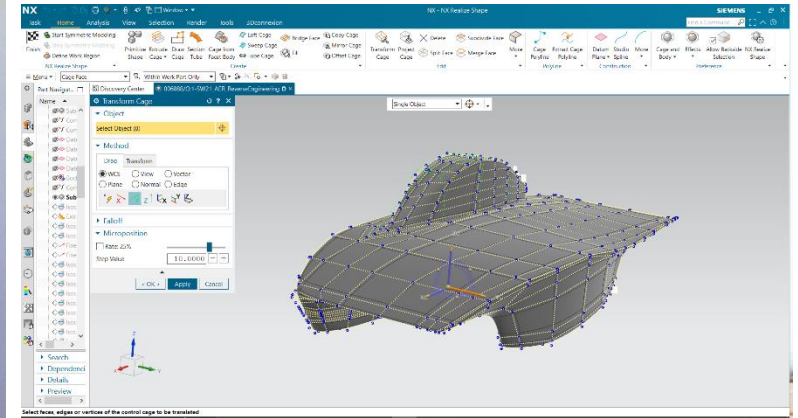
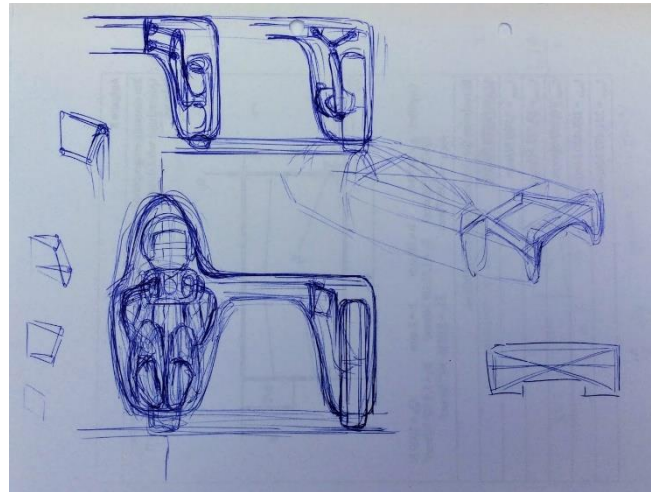


Optimization Loops

 **Energy-consumption model**

Design Environment Requirements

- At the beginning of designing
 - **Quick and easy** implementation of ideas in CAD
 - **Fast simulations** in CFD
- Towards the end of designing
 - **Detailed** modelling
 - **Complex** simulations
 - **Extensive** post-processing

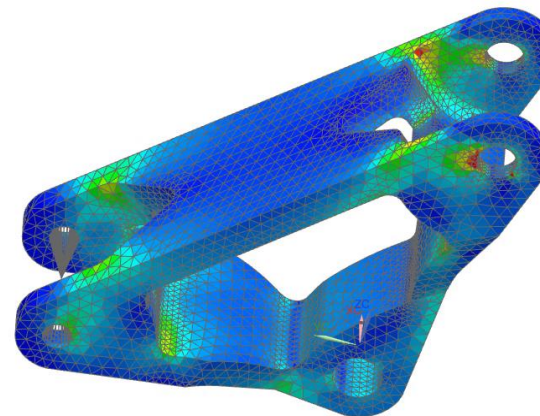
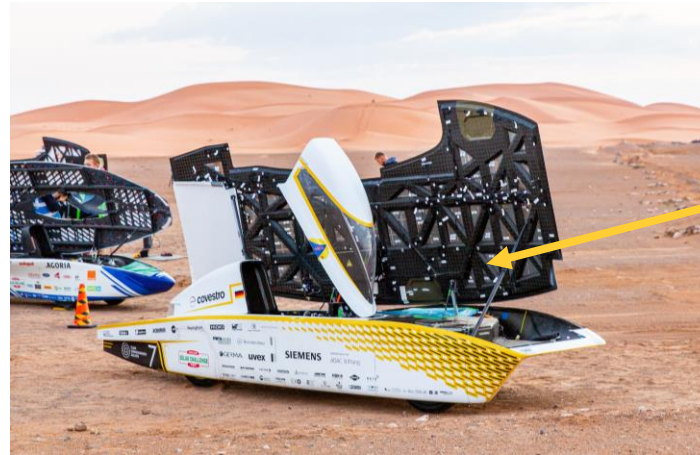


Data-Driven Design – Data Management



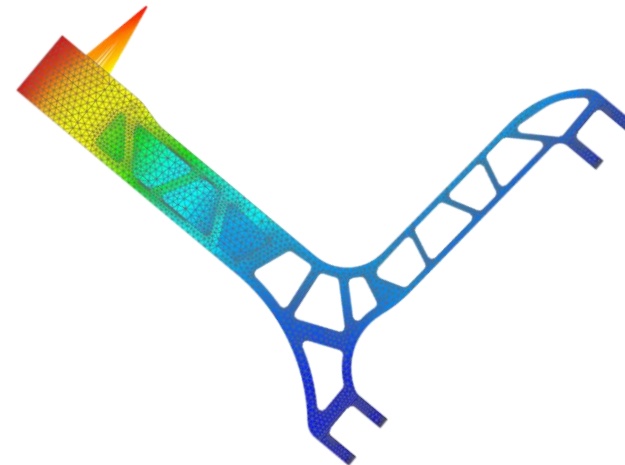
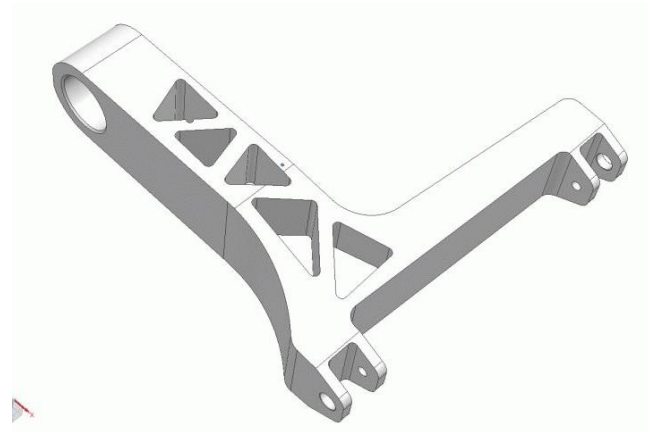
Simcenter – FEM – Topology Optimization

- Best possible **lightweight construction** with **reliable safety**
- **FEM simulations** for conventional metal production
- **Topology optimization** as inspiration for machining
- Design of **metal 3D printing** components



Simcenter – Lightweight Structures with OptiAssist

- Extended collaboration with **GRM Consulting**
- Initially, only for the **fine-tuning of the optimization**
- First example of use in the Covestro Photon:
 - Central component of the rear suspension
 - A total of **17% weight reduction** through OptiAssist
- This season, **deep commitment to development** from the start

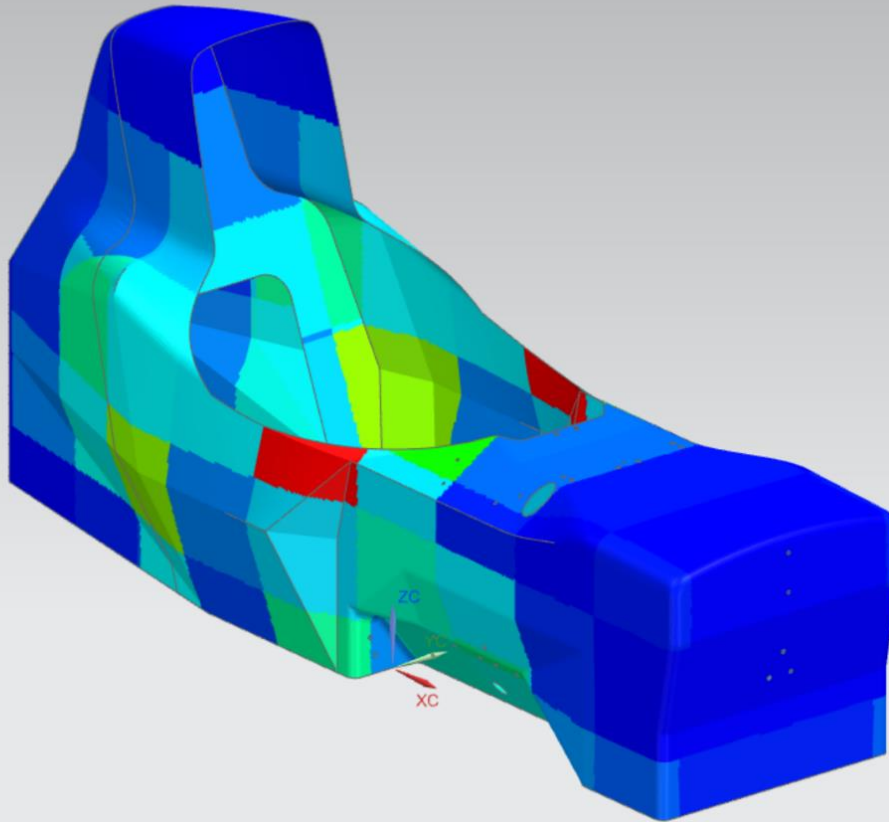
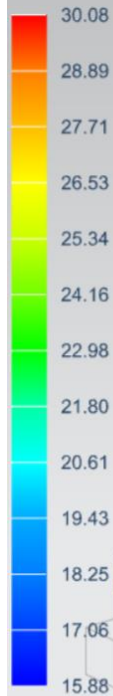


Data-Driven Design – System Simulation

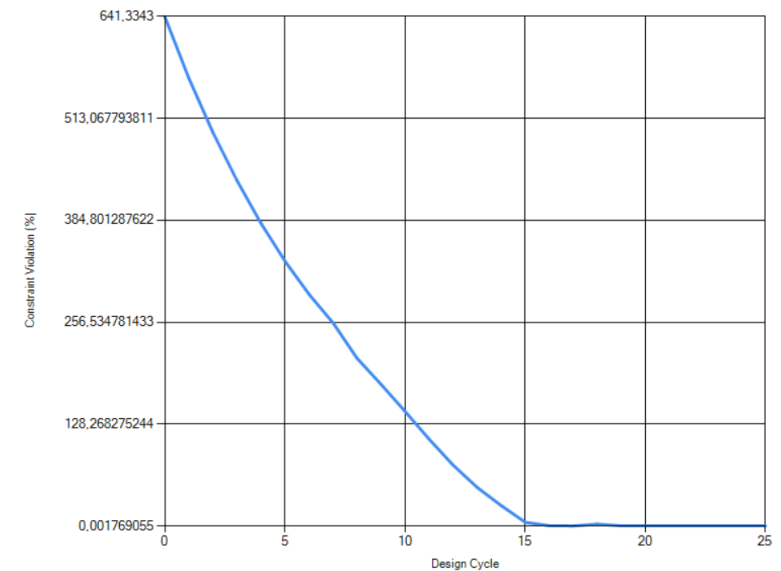
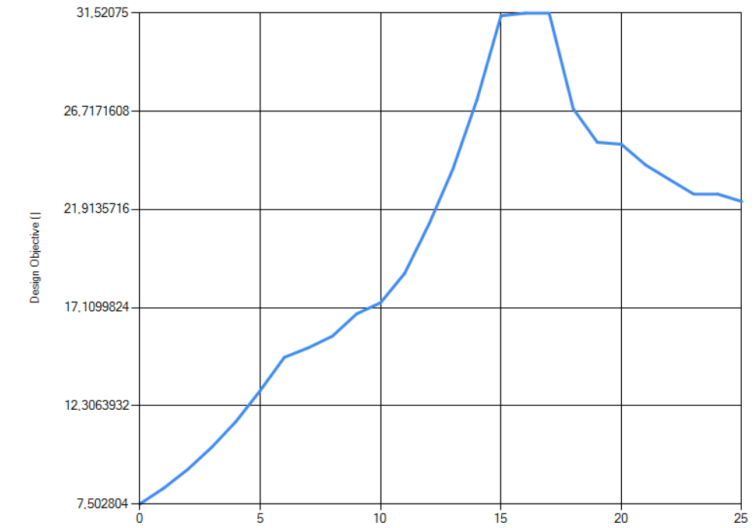


System Simulation - Side Impact Optimisation

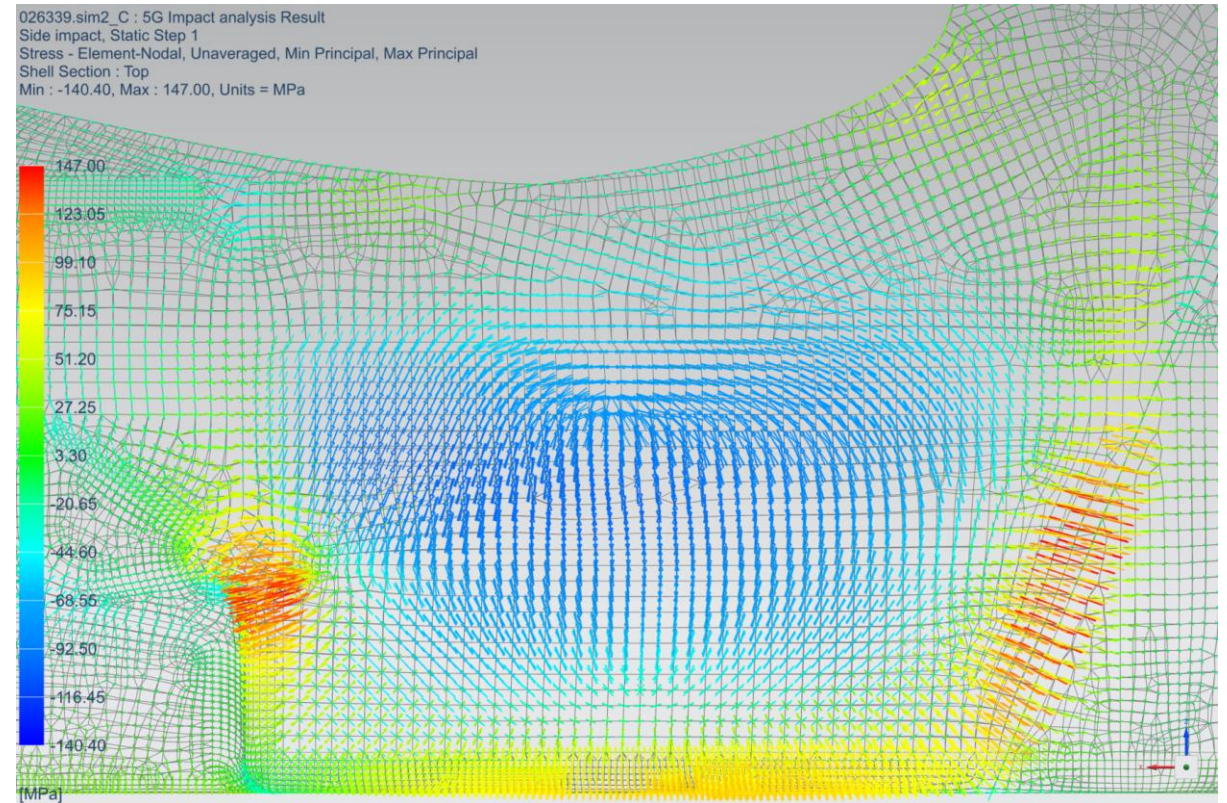
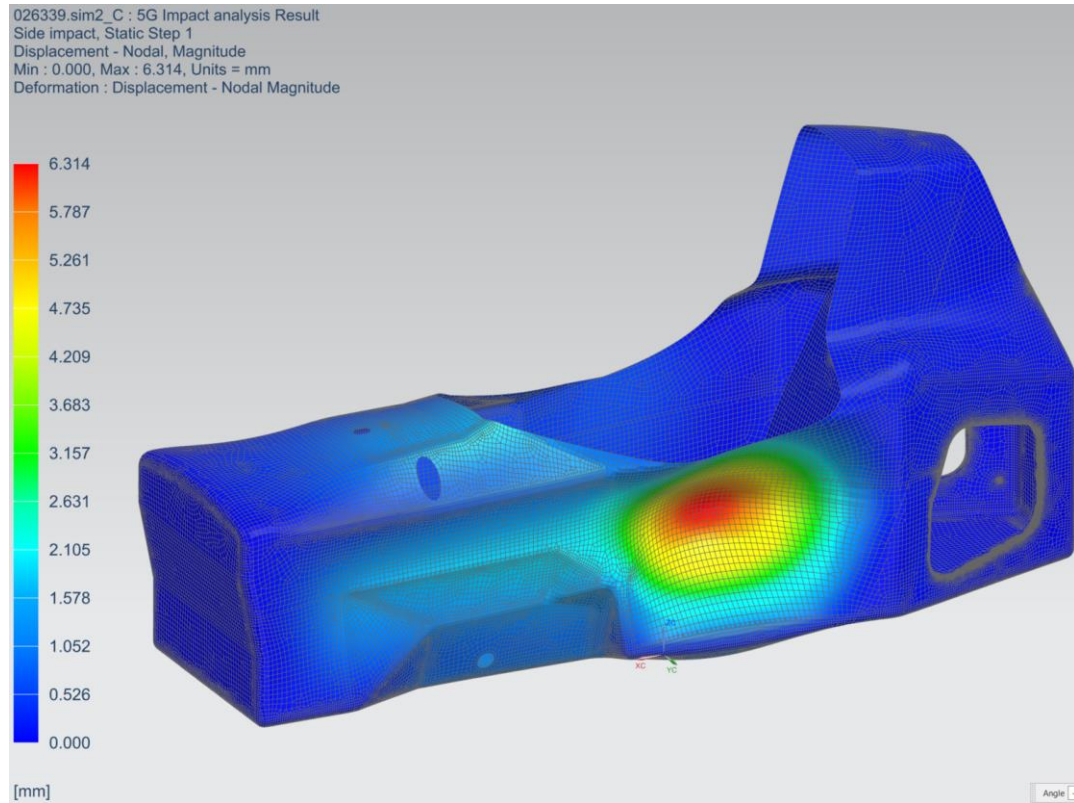
026129.sim1_c-soln_1_s : OptiAssist Solution Result
OptiAssist Design Cycle 25, Static Step 1
Total Laminate Thickness - Elemental, Scalar
Min : 15.88, Max : 30.08, Units = Unitless



[Unitless]



System Simulation - Fibre Orientation Optimization



Data-Driven Design – Design Space Exploration



Thank you for your time!

