Engineering and simulation of Vehicle Headlamp systems at HELLA

Experience of TIER 1 supplier with 3Dx CATIA Behavior modeling, V5 and 3Dx co-existence

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Content

01

Forvia HELLA

Products, engineering, our tasks in engineering

HELLA Mohelnice

Overview

Established 1992
D & D center
Fully Competent Development HUB >500 Empl., Fully Competent Measuring and Testing Lab
Production location

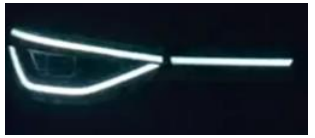
General Information

- Employees: 3325
- Customers: BMW, Audi ,Škoda, VW, Daimler , Ford, Jaguar Land-Rover, GM, Renault,Seat
- CATIA V5 releases : R19 → R32
- Development customer groups: 4+

SKODA FELICIA

BMW iX

Audi



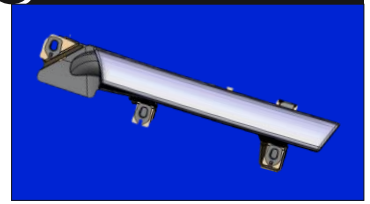
VW

Product Groups

1 Headlamps

2 LED Modules

3 Auxiliary Lamps



Technologies

- Duroplast molding
- Automated process lacquering – metalizing
- Thermoplast injection molding
- Automated molding – metallization, packaging, visual inspection
- Thickwall optics and components
- Light guides for headlamps
- Fully automated process for 1K and 2K lenses
- Laser technology

HELLA Lighting Product portfolio

Leading vehicle lighting supplier

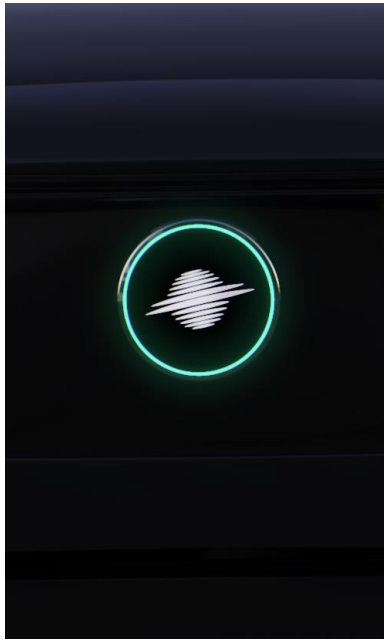
Light is essential to both **seeing and being seen**. Since vehicle lighting is so important to the safety of everyone on the road, HELLA develops innovative lighting systems that offer a high level of **driving comfort** while also providing **optimum illumination** of the road ahead. But that's not all: Design is also an increasingly important factor where HELLA develops systems enabling designers to create **unique brand-specific styles.**

Headlamps and modules

Rear lamps

Car body lighting

Radomes



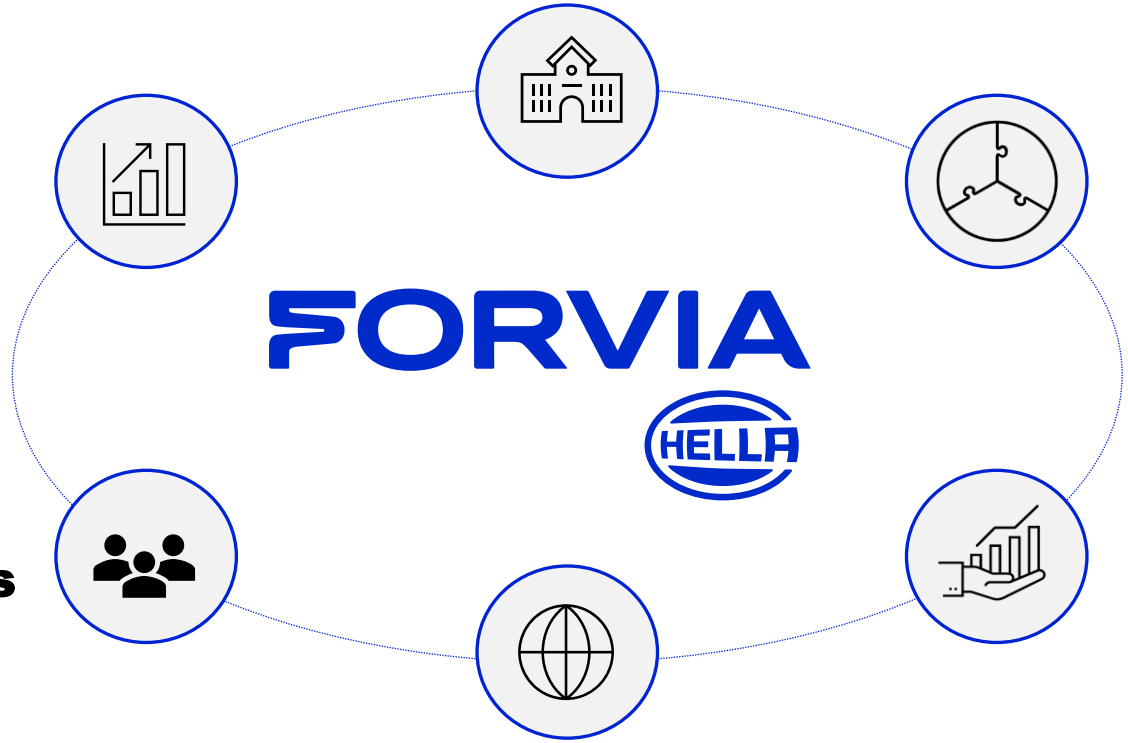
Interior lighting

HELLA has been a close and reliable partner to the automotive industry for over 120 years

HELLA in overview

Founded in 1899
Lippstadt (Germany)

€ 4.4 billion sales
Short Fiscal Year 2022
(1 June until 31 December 2022)



3 Business Groups
Lighting, Electronics and
Lifecycle Solutions

~36,000 employees
As at: 31 December 2022

~1030 CATIA V5 licenses (HD2)
More than 3500 users
(31 December 2022)

~125 locations
in around 35 countries

Faurecia + HELLA = FORVIA
A global leader in automotive technologies

A Group combining profitable growth and innovation,
well placed to meet the strategic evolutions transforming our industry

7th global automotive technology supplier	**1 in 2 vehicles** worldwide equipped with FORVIA products	**6** Business Groups	**80+** automotive customers
76 R&D centers	**~2,500** CATIA V5 licenses	**14,000+** patents	**1,000** programs in 2022
291 Plants/ industrial sites	**43** countries	**150** nationalities	**15,000** R&D engineers	**157,000** employees

All figures at December 31, 2022

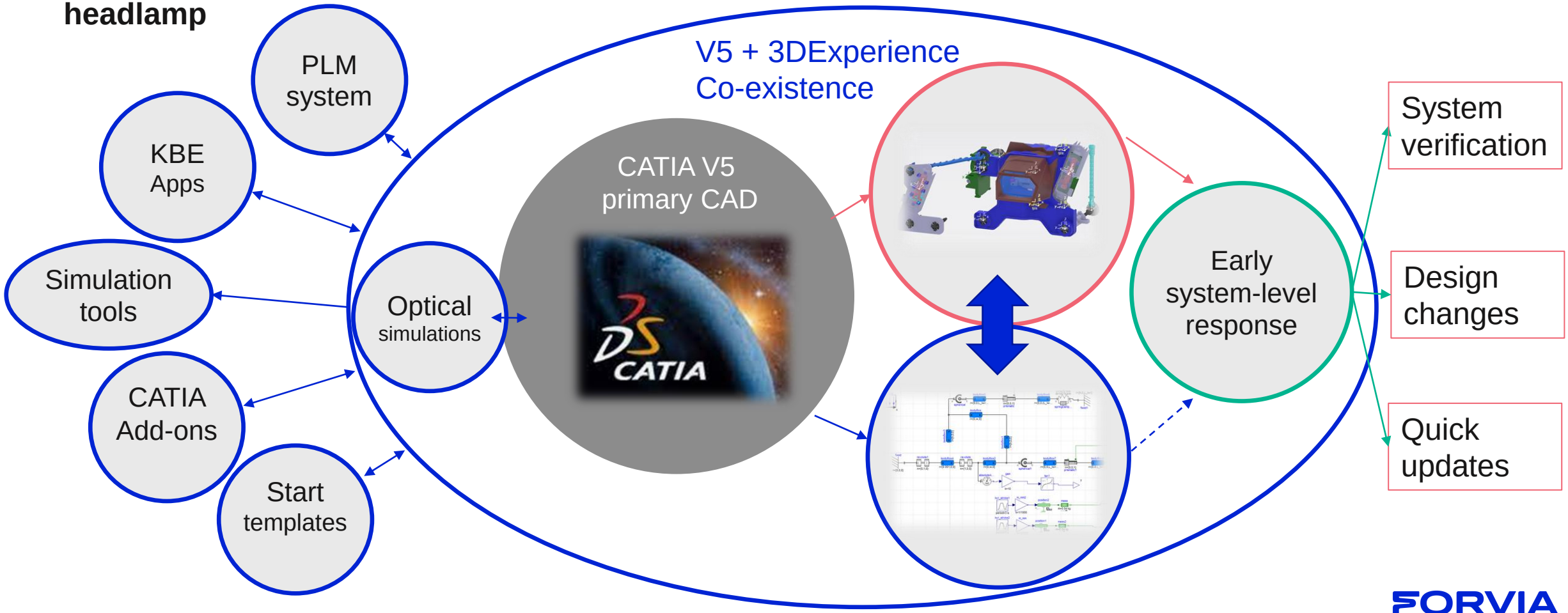
02

Our engineering environment with CATIA V5 and 3DEXPERIENCE co-existence

Primary CAD system CATIA V5 in co-existence with 3DEXPERIENCE

Delivery of early system-level response helps to verify design and drive changes in right time

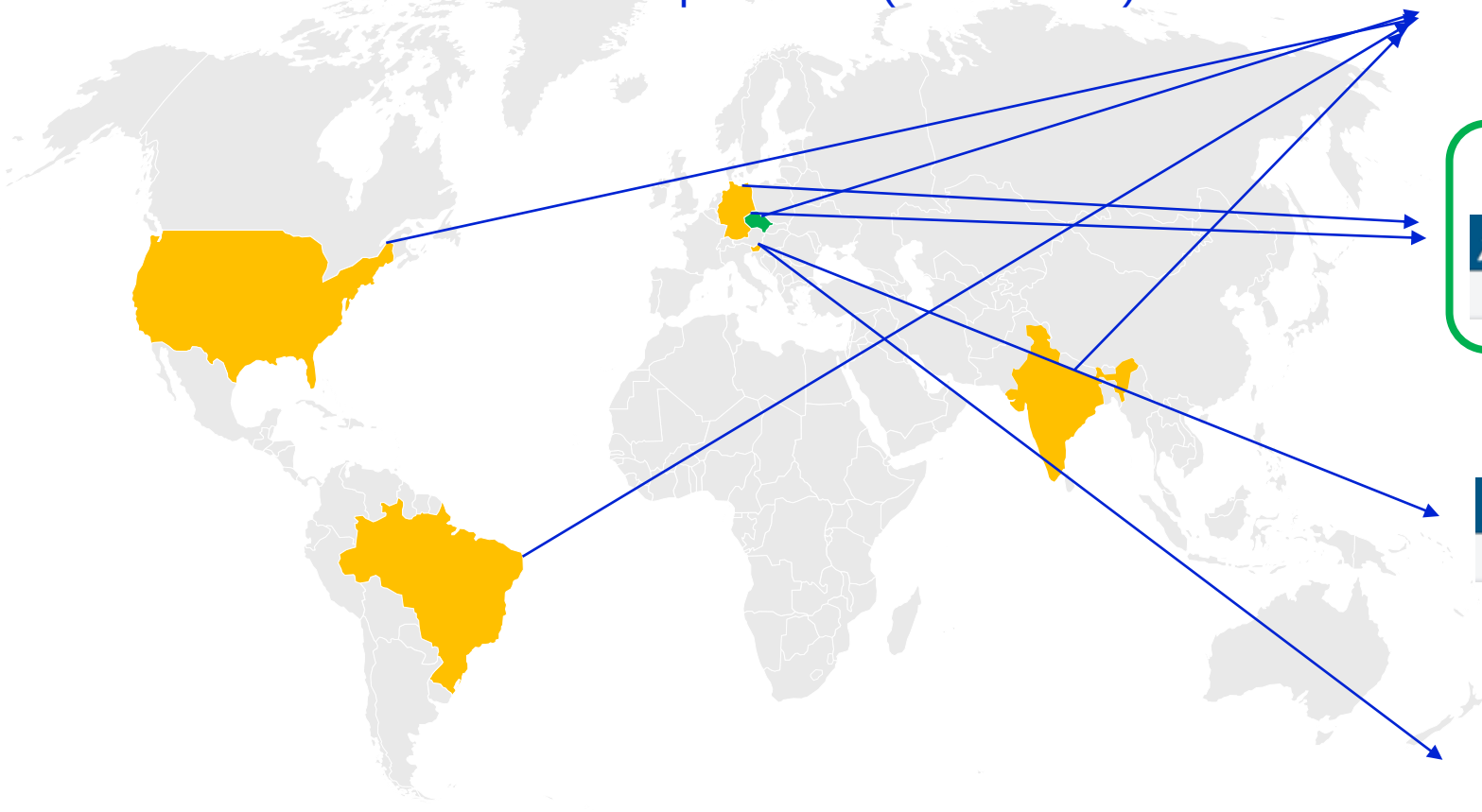
› **Co-existence between V5 3D data and 3Dx systems is a key factor in an early virtual validation of headlamp**



3DEXPERIENCE innovative solutions utilized at HELLA globally

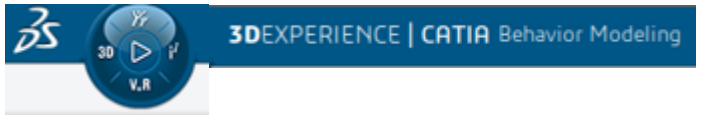
Business innovation initiatives lead the way for improvement in internal process efficiency

- 3DExperience apps addoption based on business needs and opportunities
- HELLA has 11 roles with 106 aplications (OnPremise)



Test - Electrical systems design

Productive - CATIA Systems



Productive - xGenerative design

Pilot - MCAD in 3Dx Native design

CATIA V5 and 3DEXPERIENCE co-existence, 3D data basis for MBSE

CATIA V5 data transfer to 3DExperience CATIA, to get interactive automatic updates of system

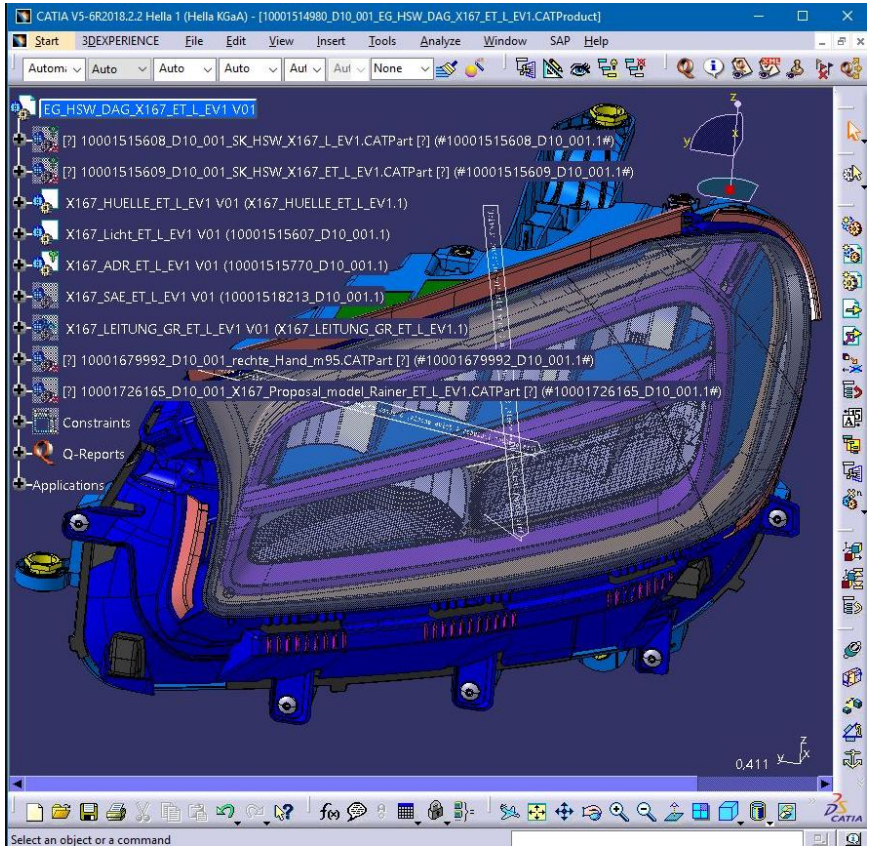


Illustration picture

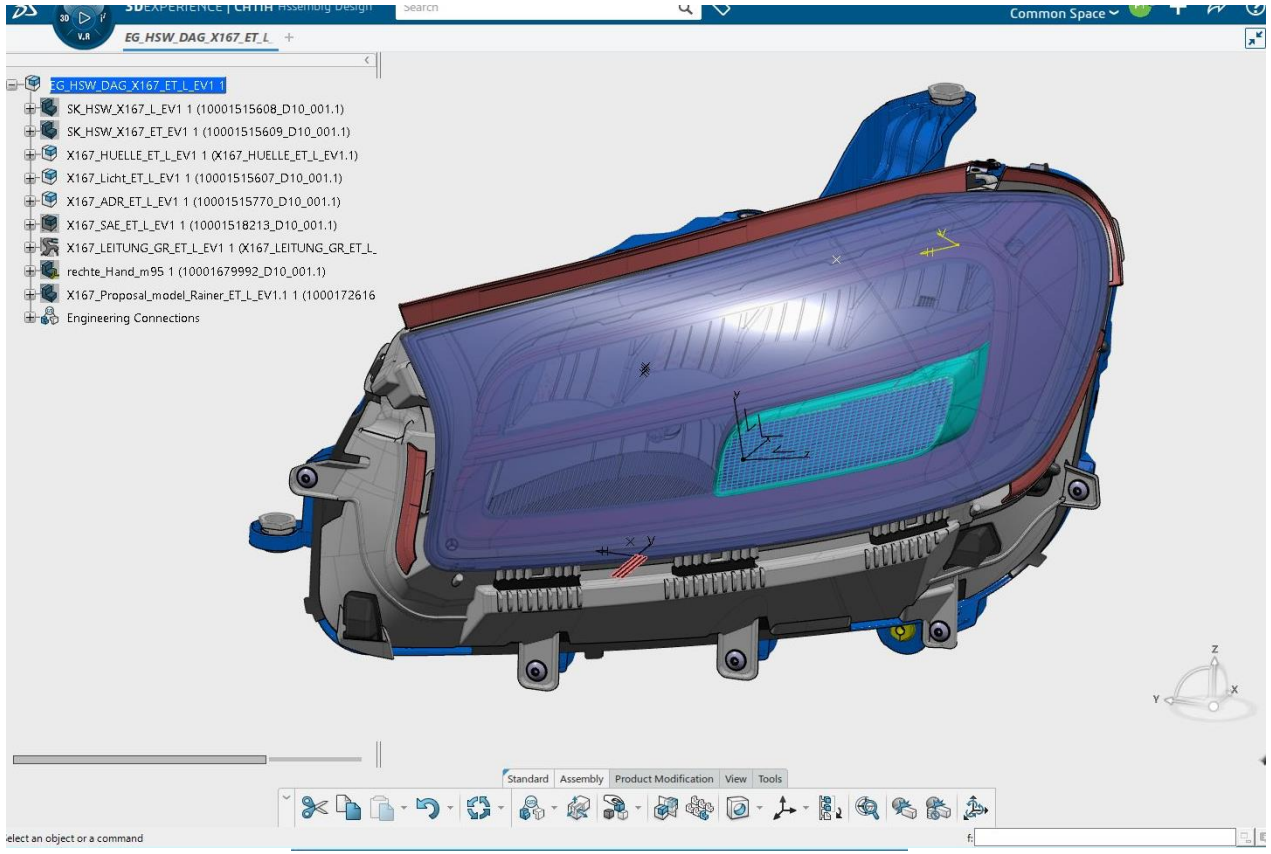


Illustration picture

- 3D geometry as an interactive basis for a seamless and quick-updatable system simulations

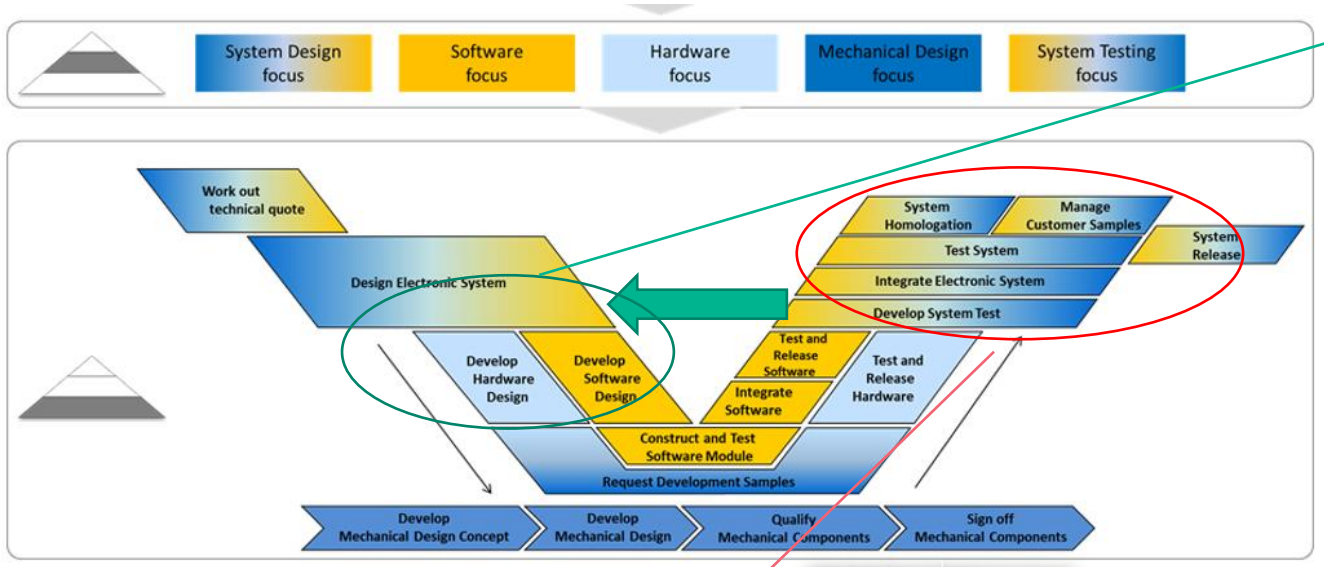
03

Our development process with Dymola contribution

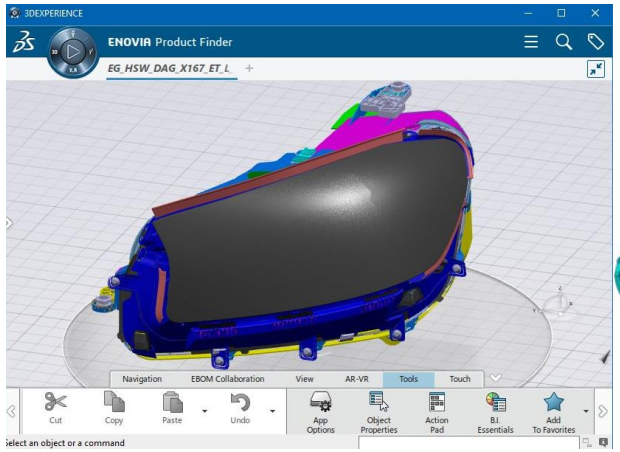
Headlamp development process and system simulations in it

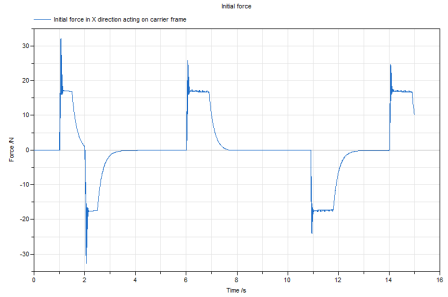
Virtual testing in early development phase, prior to expensive physical testing at the end of V-model

- **3DExperience Behavior modeling results shows future products behavior and guides teams to a first time right solution from the very beginning**



Virtual testing of future system behavior



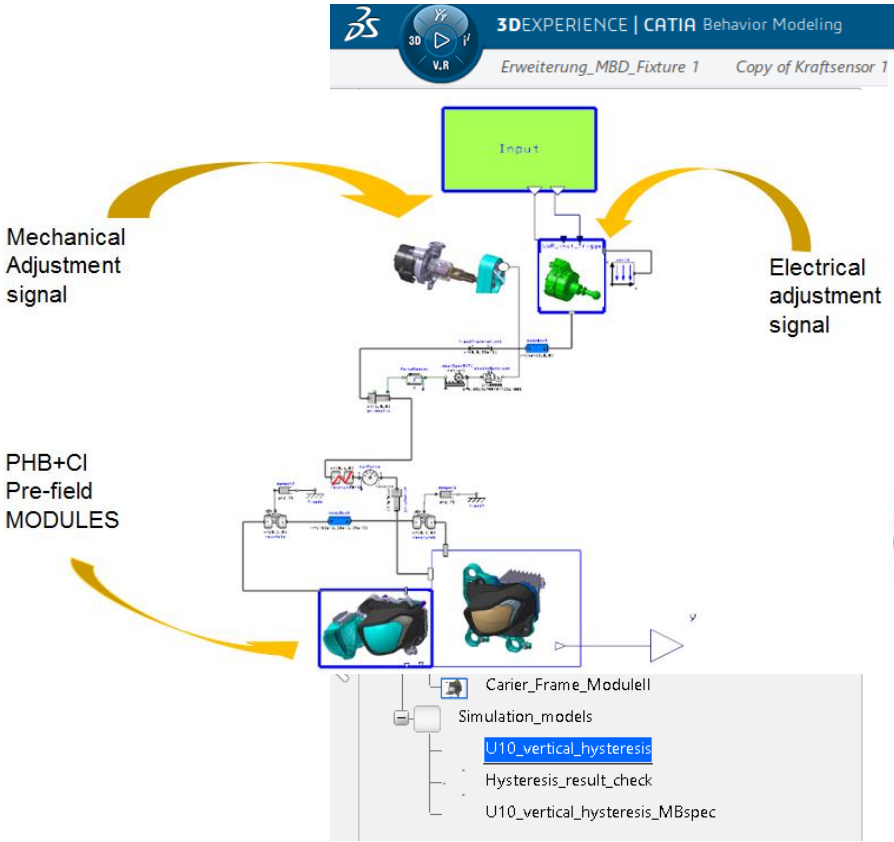


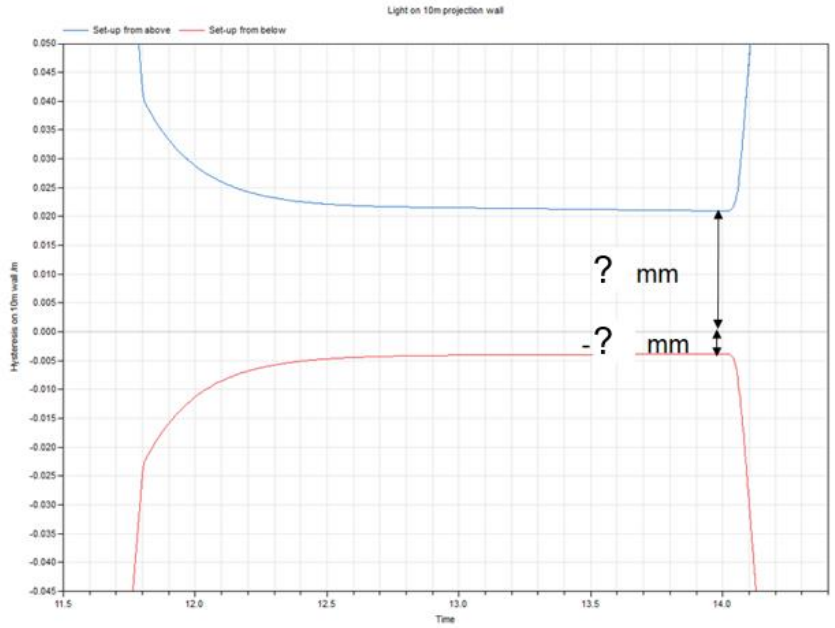
Traditional physical testing phase

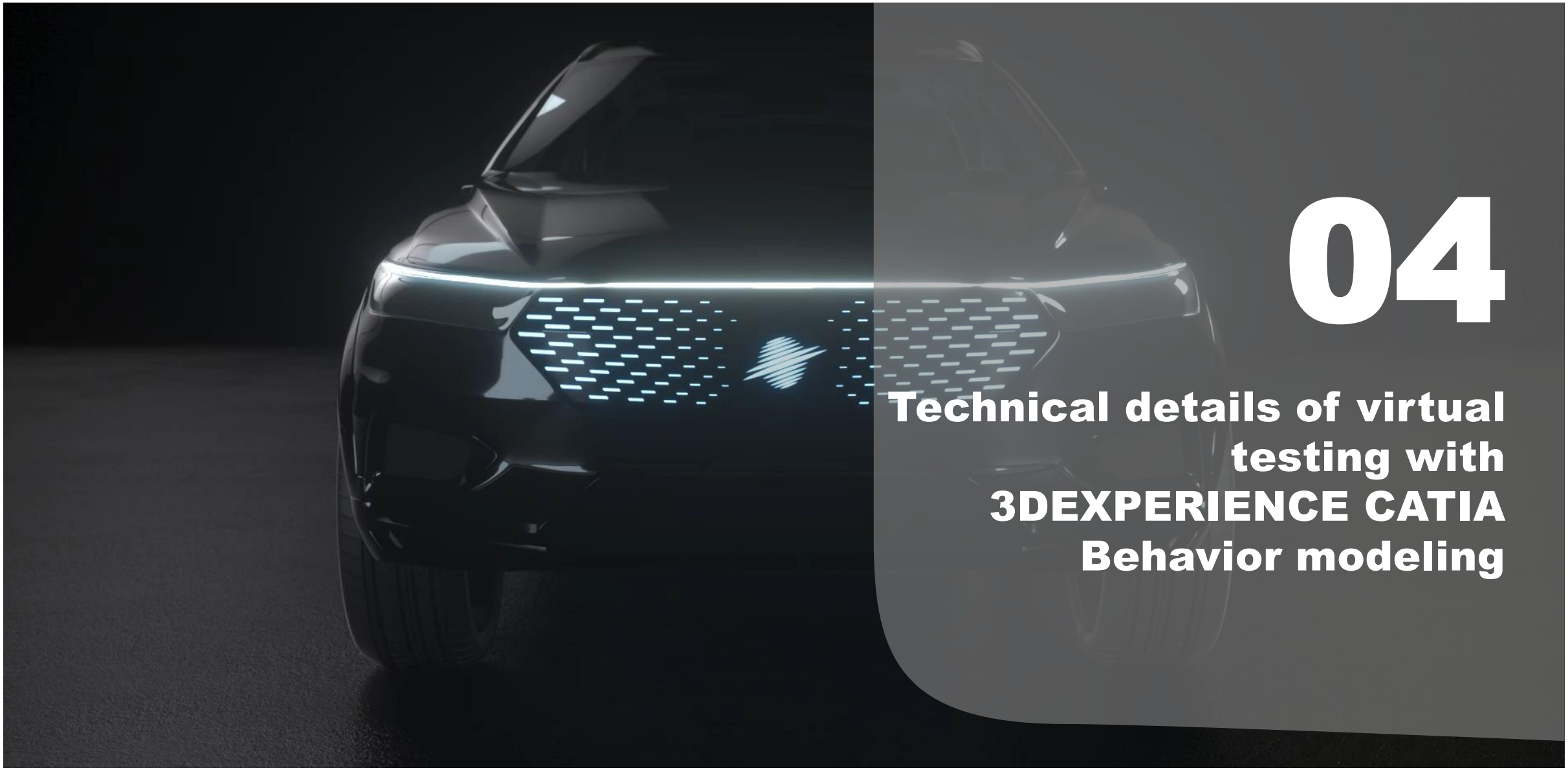
CATIA V5 a 3DEXPERIENCE co-existence, HELLA Mohelnice

System simulation with CATIA Behavior modeling in 3DExperience

- Multidisciplinary modelling and analysis connects multiple physical disciplines with one 3D model
- Fundamental part of selected headlamp development projects





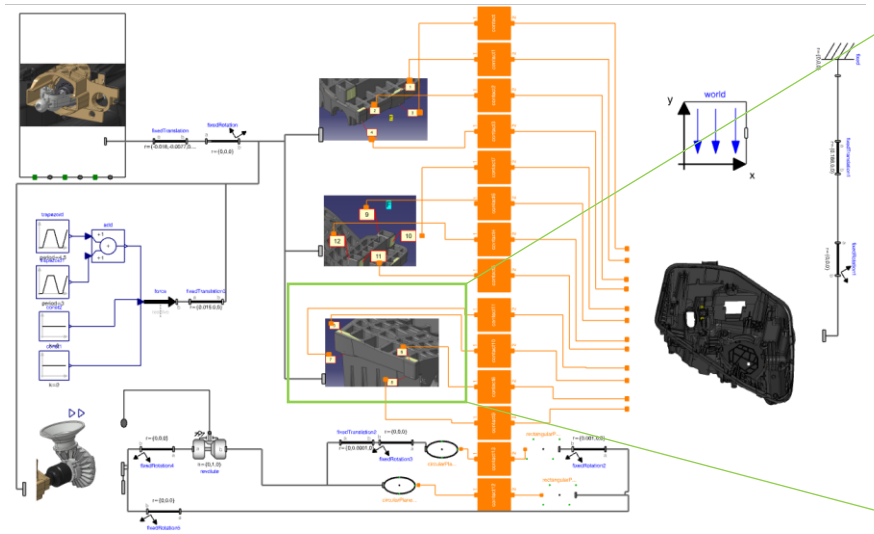


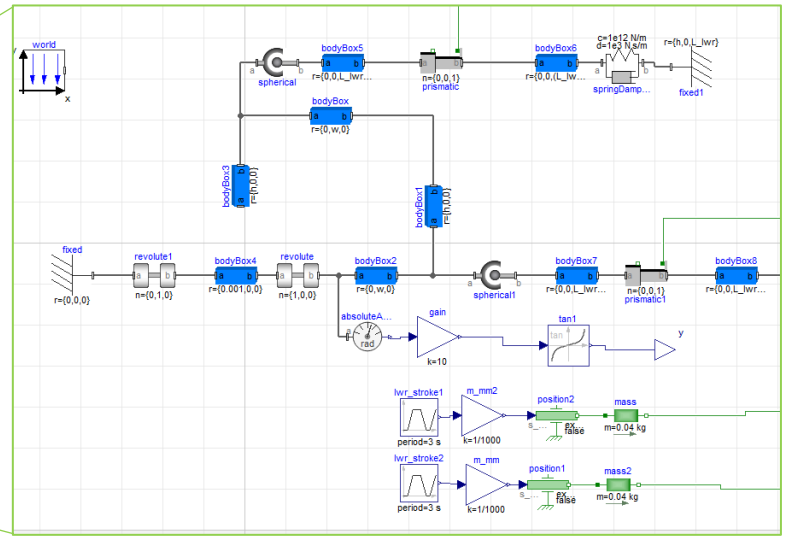
04

Technical details of virtual testing with 3DEXPERIENCE CATIA Behavior modeling

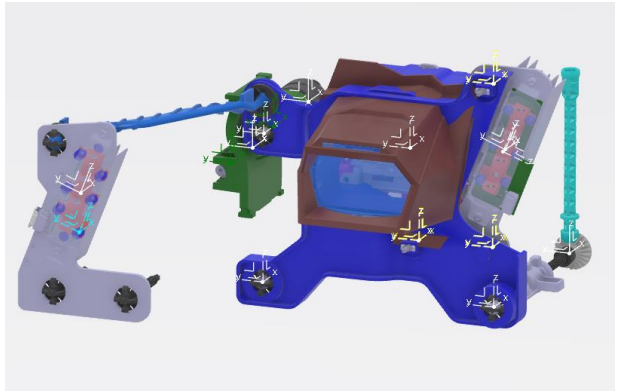
3DEXPERIENCE CATIA Behavior modeling with V5 3D data imported

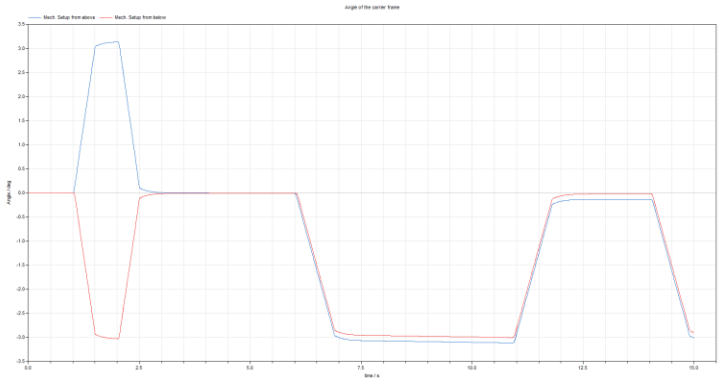
Physical behavior of pre-development system can be analyzed and possible failures identified

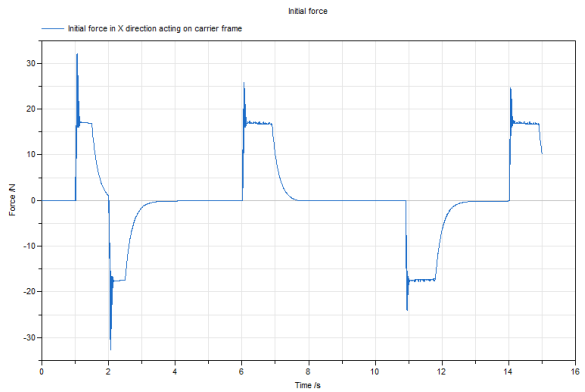





```
model test1
  parameter Real w(final unit="m") = 1 "Width of carier frame";
  parameter Real h(final unit="m") = 2 "High of carier frame";
  parameter Real L_lwr(final unit="m") = 1 "Lenght of adjustement rod";
  parameter Real R_b(final unit="") = 1 "Rotation backlash";
  parameter Real T_b(final unit="mm") = 1 "Translation backlash";
  parameter Real g_rat(final unit="rad/m") = 100 "Gear ratio";
  parameter Real ver(final unit="mm") = 1 "vertical adjustement";
  parameter Real hor(final unit="mm") = 1 "horizontal adjustement";
  parameter Real beta(final unit="rad") = 0.1 "beta angle";
  Modelica.Mechanics.MultiBody.Parts.BodyBox bodyBox(
    r={0,w,0},
    length=w + w/20,
    width=w/10,
    height=w/10)
                a ;
  Modelica.Mechanics.MultiBody.Parts.BodyBox bodyBox1(
    r={h,0,0},
    length=h + w/20,
    width=w/10,
    height=w/10)
                a ;
  Modelica.Mechanics.MultiBody.Parts.BodyBox bodyBox2(
    r={0,w,0},
    length=w + w/20,
    width=w/10,
    height=w/10,
    innerWidth=0)
    a ;
  Modelica.Mechanics.MultiBody.Parts.BodyBox bodyBox3(
    r={h,0,0},
    length=h + w/20,
    width=w/10,
    height=w/10)
                a ;
  Modelica.Mechanics.MultiBody.Parts.Fixed fixed
    a ;
  inner Modelica.Mechanics.MultiBody.World world
    a ;
  Modelica.Mechanics.MultiBody.Parts.BodyBox bodyBox4(r={0.001,0,0})
    a ;
```

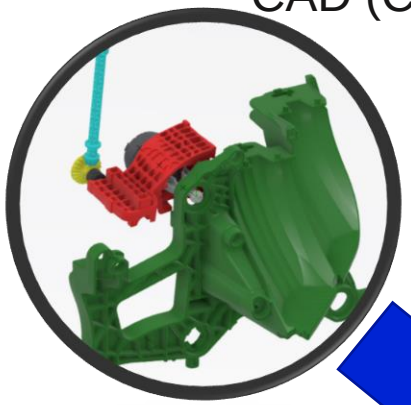


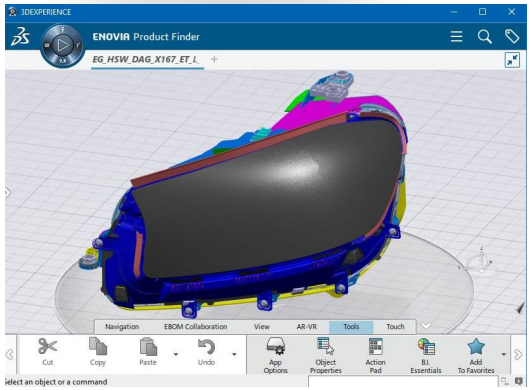




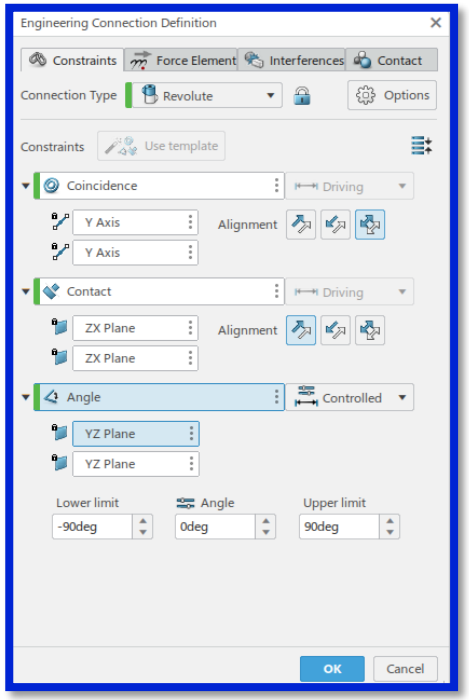
3D data used for KINEMATICS, which is transfered to the SYSTEM

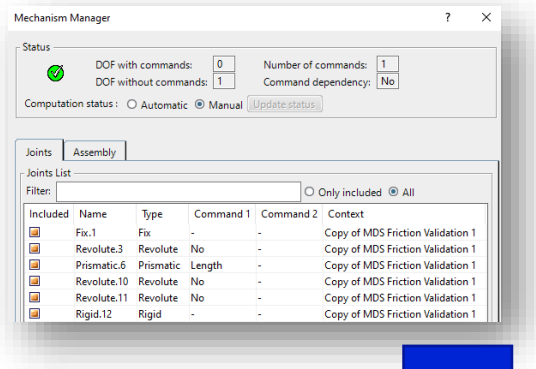
CAD (CATIA)



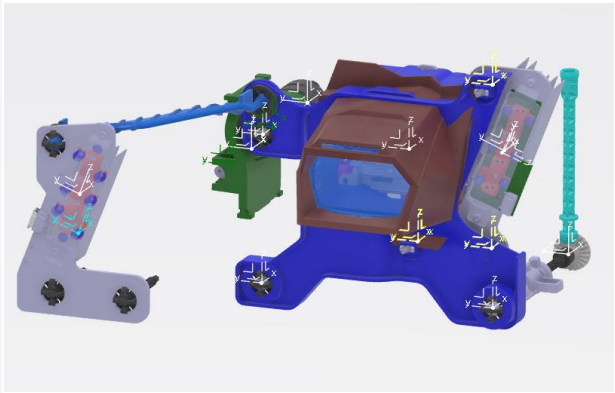


Constraints

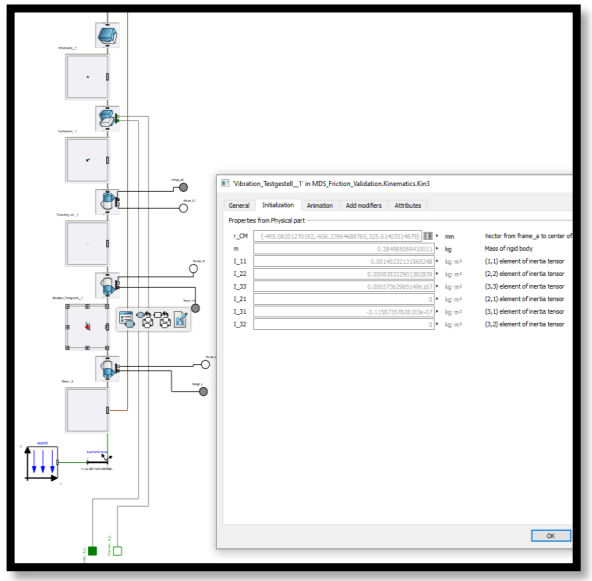




Kinematic definition
and translation (CATIA)

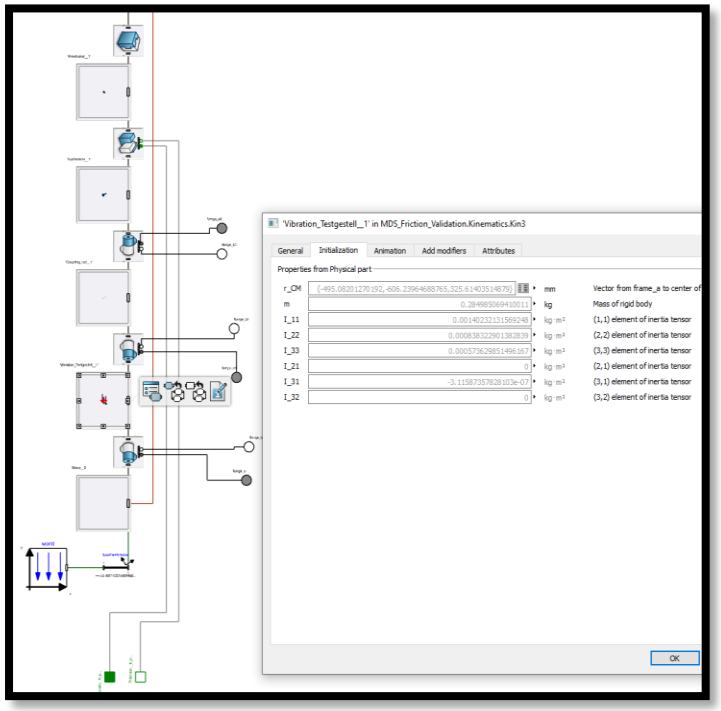


System scheme (Dymola)
based on kinematics

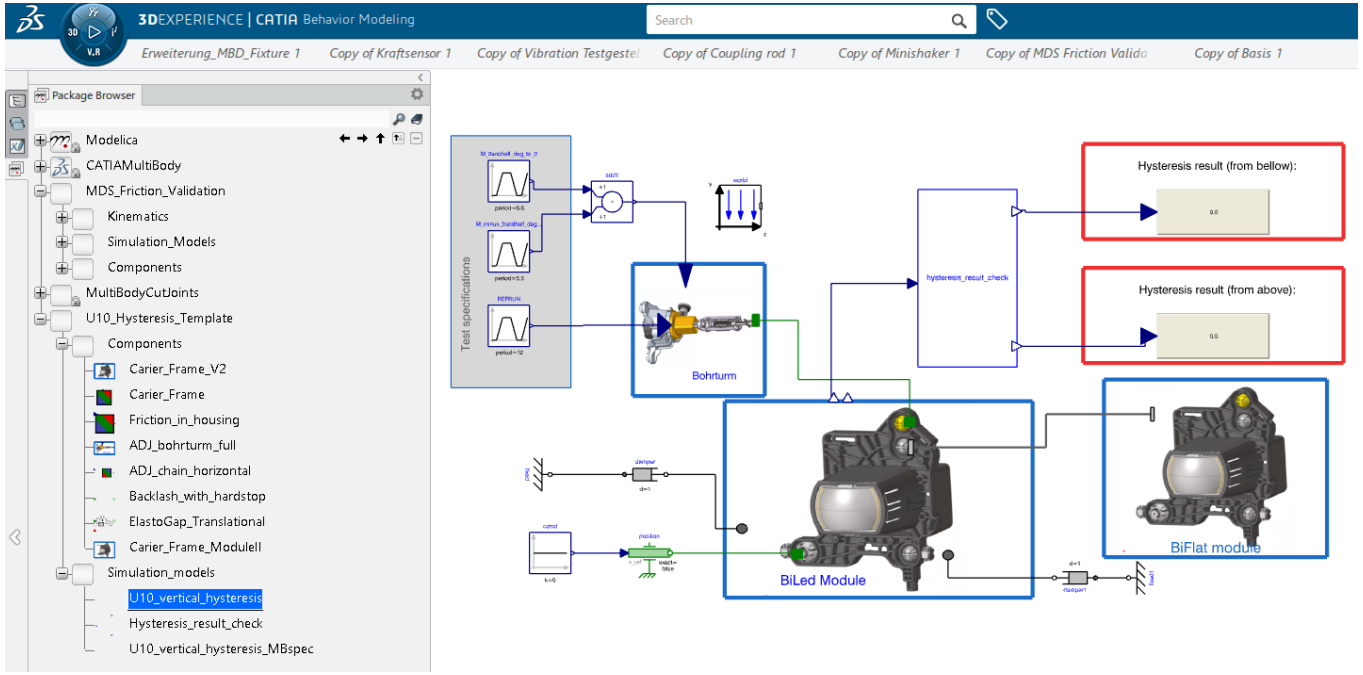


3D data used for KINEMATICS, which is transfered to the SYSTEM

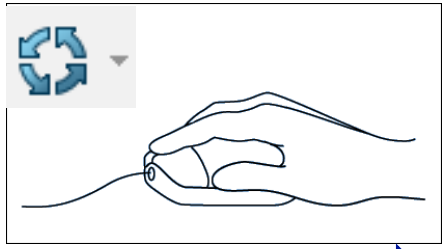
System kinematics



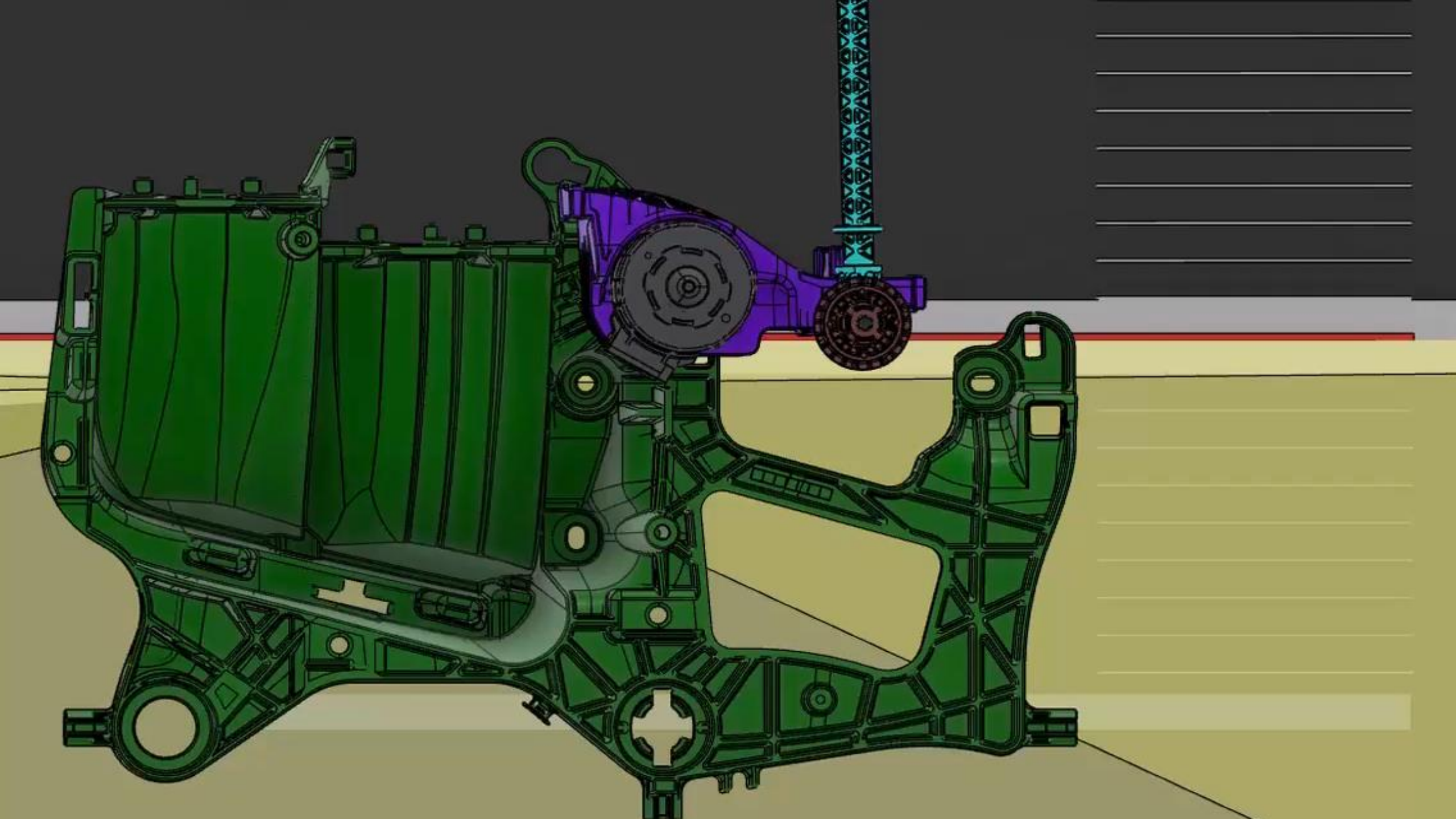
System model with kinematics based on CAD data



3D data updated by designer

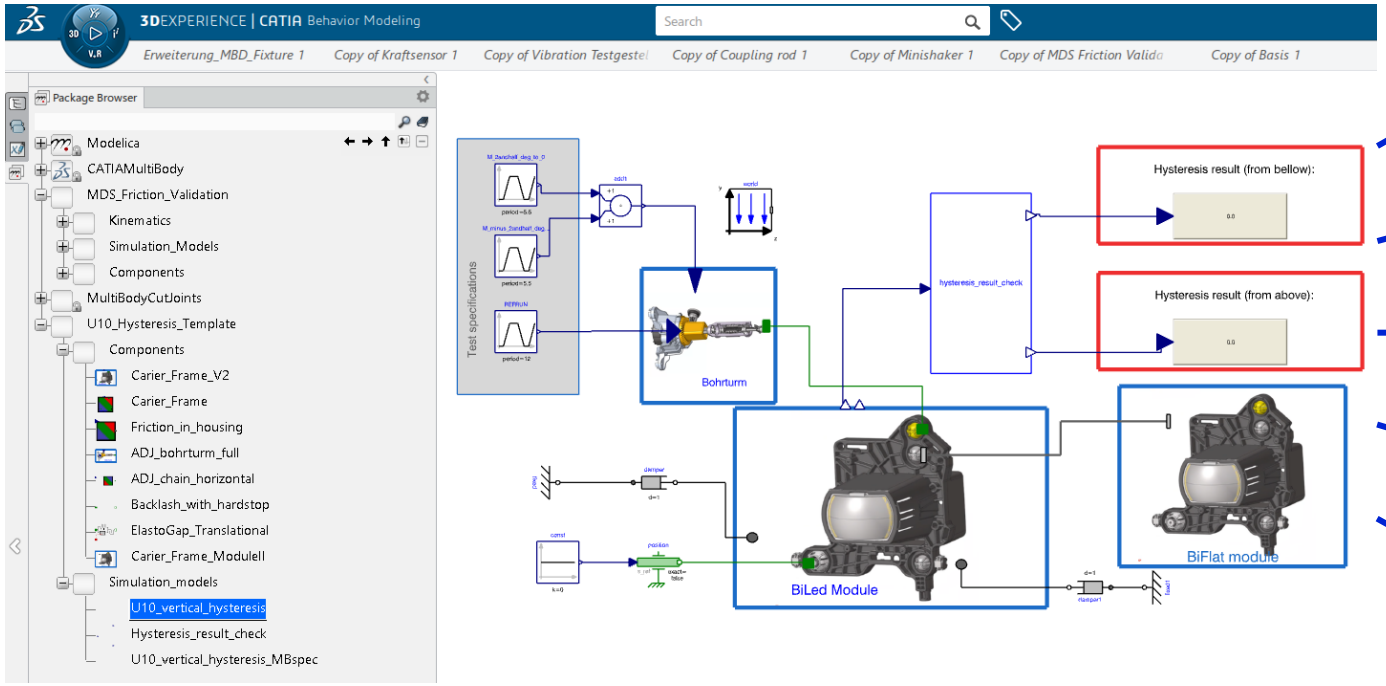


Simulation model updated with all parameters based on 3D



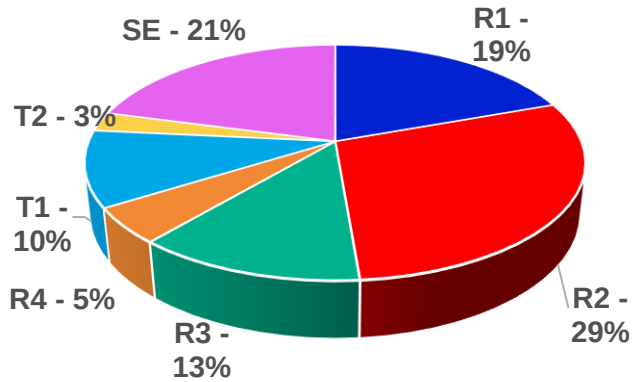
Headlamp levelling system analysis – model and validation

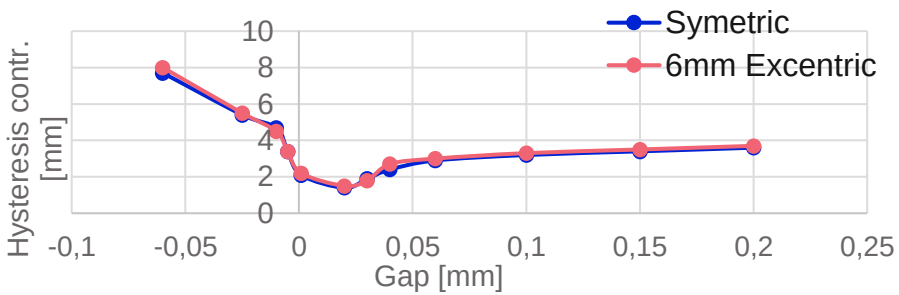
Analysis of adjustment systems



- Concept options checking
- Test result prediction
- Identification of root cause
- **Validation of internal parameters**
- Design optimization

95 % confidence interval	< 4.5-9.4 > mm
OK result probability	86 %
Average	7.3 mm



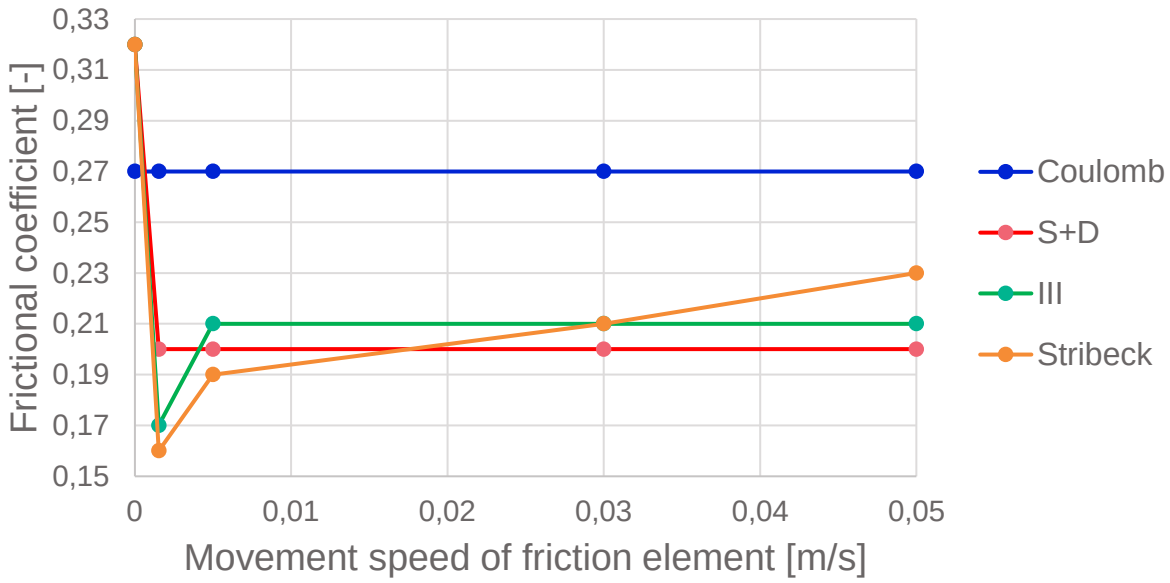


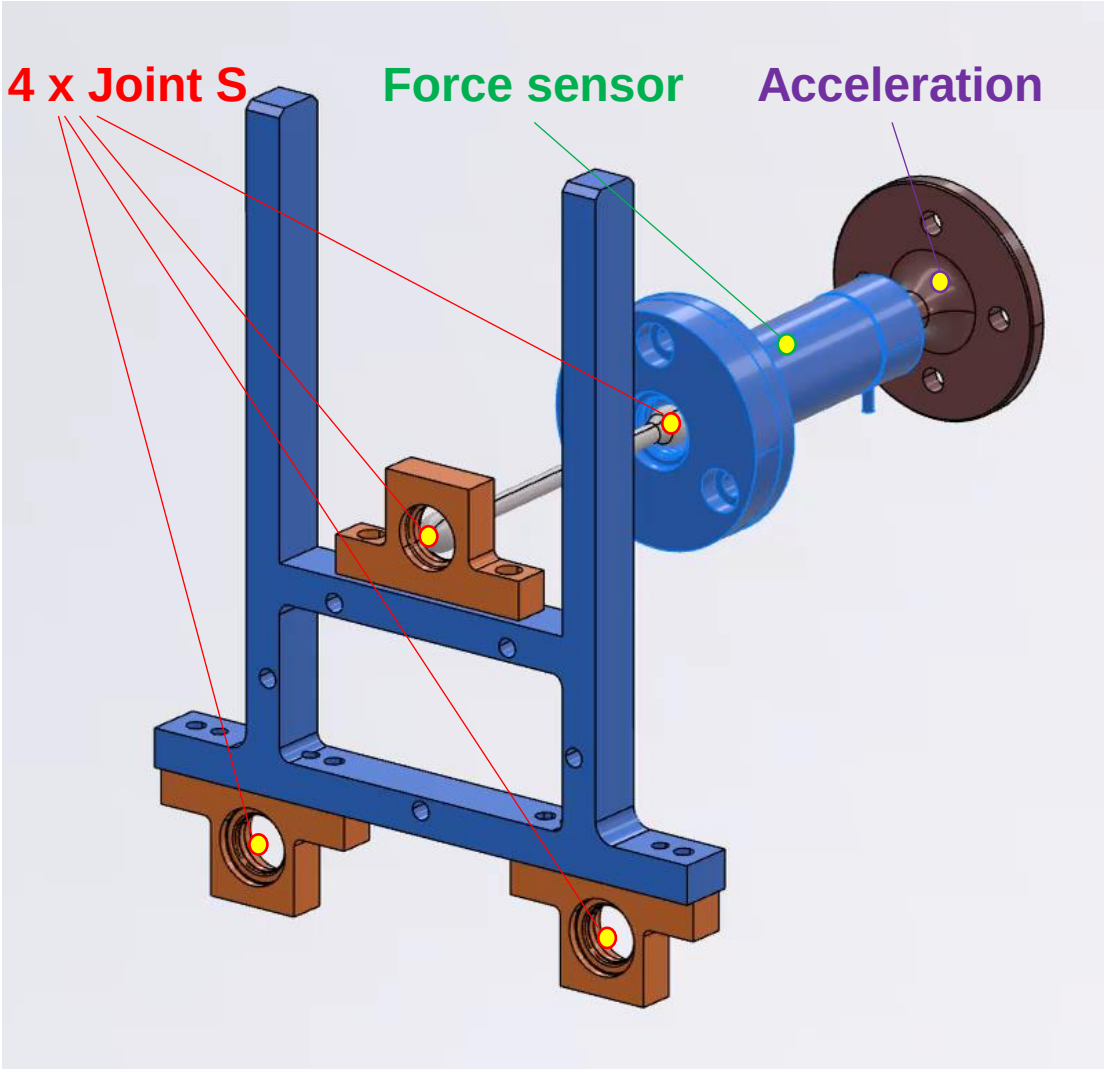
Validation of internal parameters

Evaluating fricition coefficients

› Task: Evaluate precise friction parameters of specific type of joint used in systems

- Verify a frictional approach based on measurments



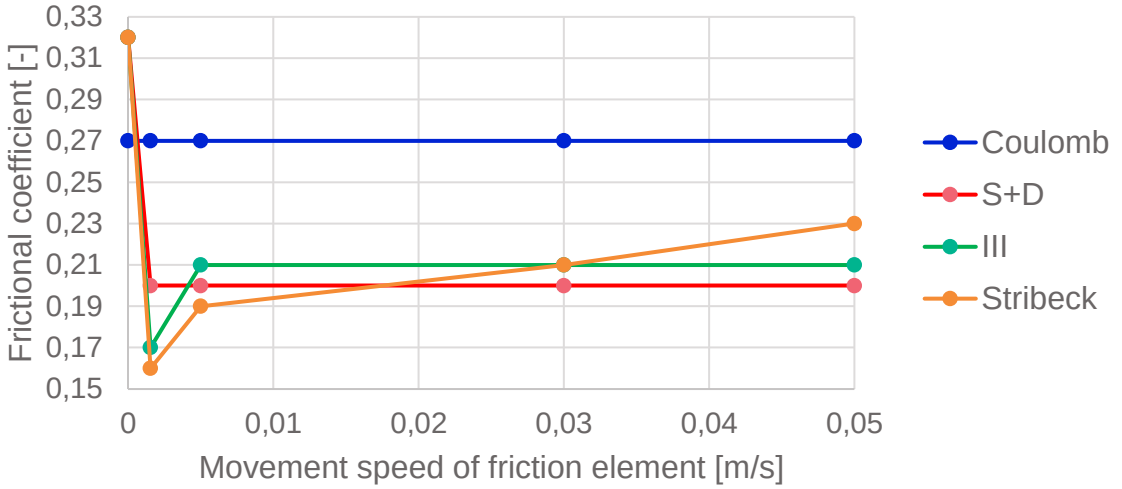


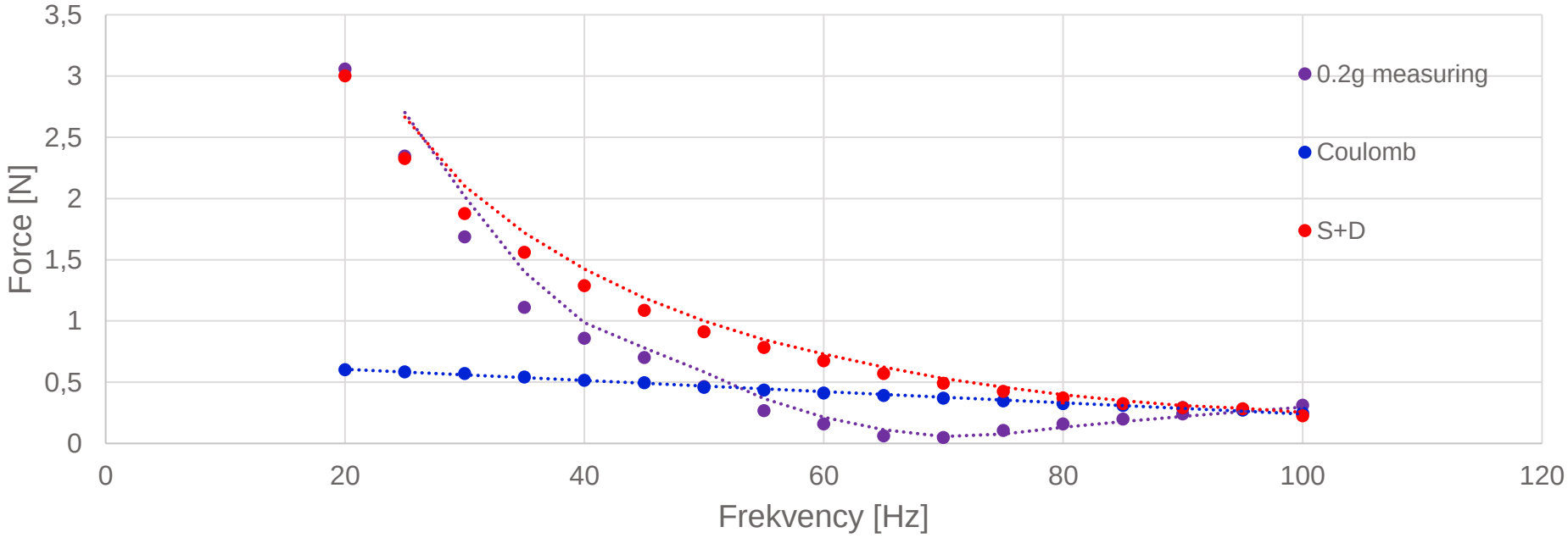
Friction validation model

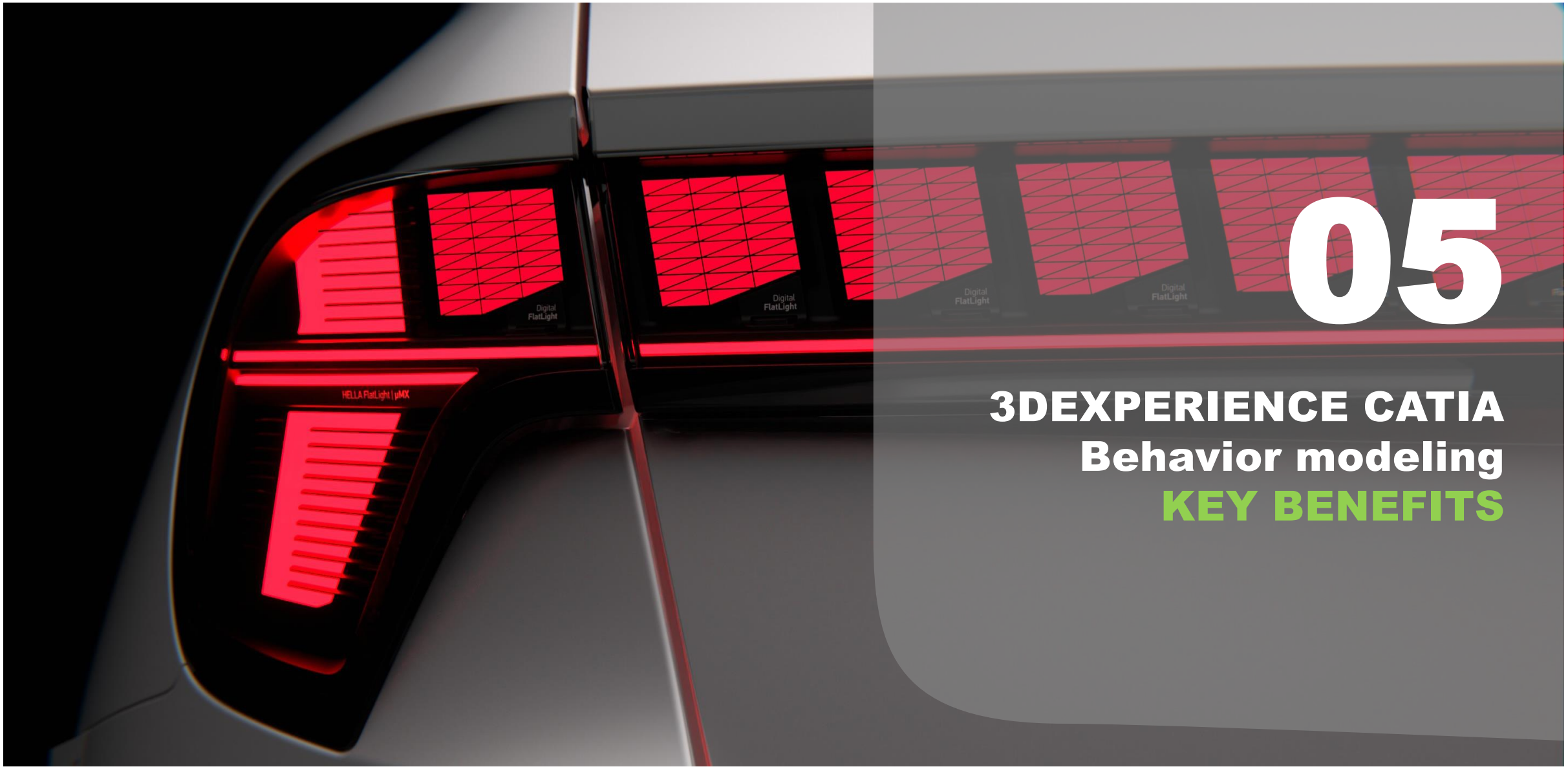
Evaluating fricition coefficients

› Task: Evaluate precise friction parameters of specific type of joint used in systems

- Verify a frictional approach based on measurments







05

3DEXPERIENCE CATIA
Behavior modeling
KEY BENEFITS

Benefits for headlamp development

Conclusion

Simulation based

- Calculation of geometric parameters

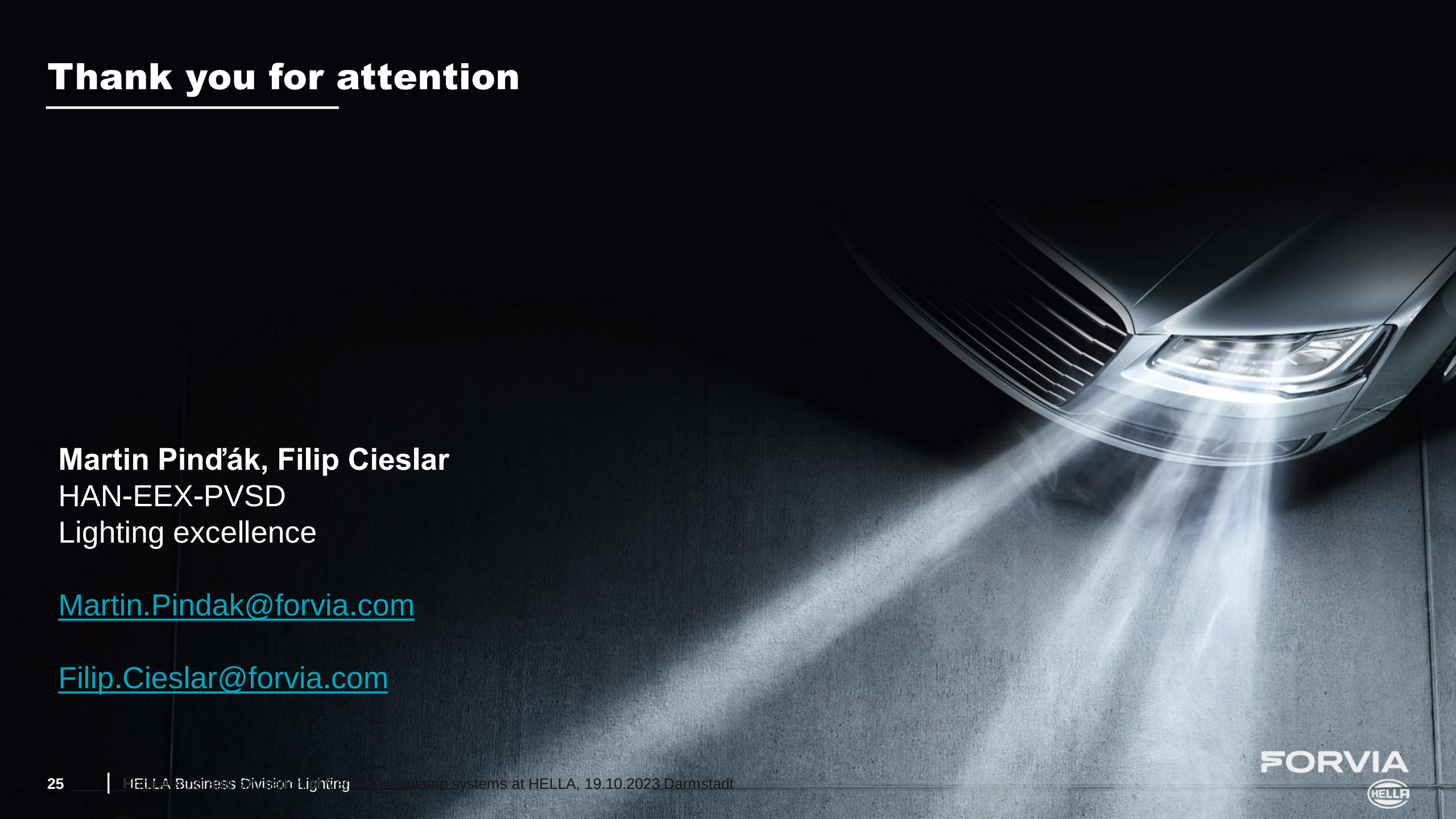
(Inertia, mass, tenzors, etc.)

  - **Development time reduced by 14-20 %**
- Update management with current 3D data
  - **Development time reduced by 6-10 %**
- All models on cloud – easy sharing

Project based

- Reducing the development time/costs
- Test result prediction
- Design optimization / comparison
- Identification of key nodes in the system
- Digitalization of testing processes

Thank you for attention



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