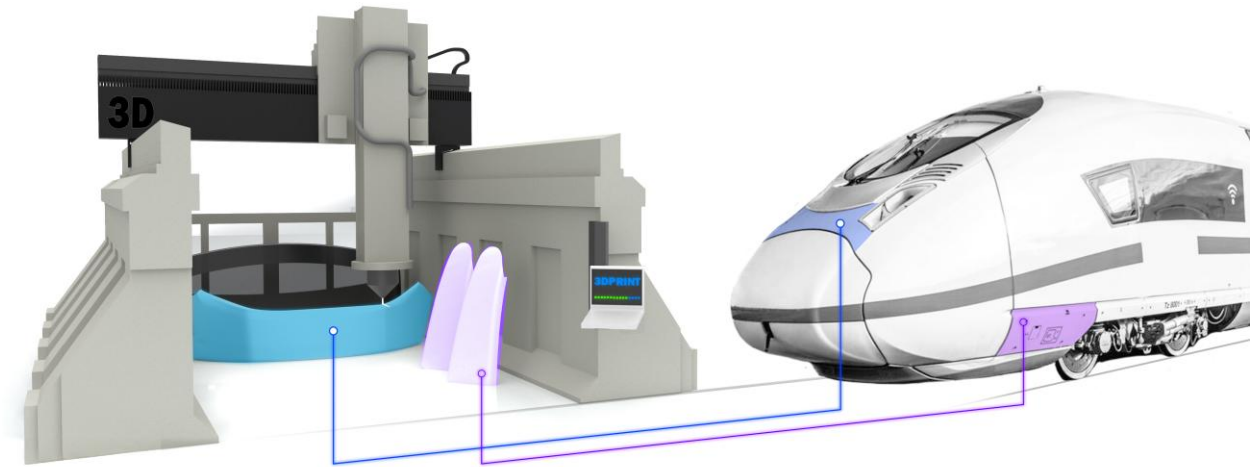
3D - FiberTrain

3D printing for large-format and heavy-duty rail vehicle components



-15 %
total component-related costs

-20 %
component-related production time

-30 %
carbon footprint

Research Partners: Fraunhofer IWU, Fraunhofer IMWS, LAKOWA, SIEMENS

Gefördert durch: Bundesministerium für Wirtschaft und Energie aufgrund eines Beschlusses des Deutschen Bundestages

TÜVRheinland® Genau. Richtig.

3D - FiberTrain

3D printing for large-format and heavy-duty rail vehicle components

GOAL – Development of a tool-free manufacturing process to produce large-scale, heavy-duty rail vehicle components

RESULTS

- **Improved mechanical properties** with minimal weight by using fiber-reinforced tapes
- **Demand-based part manufacturing** without tools
- **Compliance with fire safety standard EN45545**
- **Reduction** of overall **component costs** and **carbon footprint**

FACTS FRONT PANEL

dimensions: 1326 x 530 x 16 mm

Weight: 9,8 kg

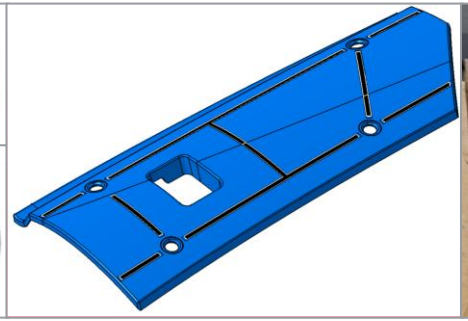
Material: PC – Blend Listolan™ 060 XL with 20% glass fiber

Printing parameter:

- nozzle temperature 275°C
- printing speed: 2600 mm/min
- printing time: 6 hours

Demonstrator vehicle: ICE 3neo 308

Demonstrator parts: front panel
front mask



Tape-reinforced front panel

RESOLVE

Resource-efficient lightweight seats

< 1 min
Production time per seat

Research Partners:

Fraunhofer IWU

ASGLAWO technofibre

FKT Formenbau und Kunststofftechnik

Technische Universität Chemnitz

Gefördert durch:
Bundesministerium für Wirtschaft und Klimaschutz
Projektträger Jülich Forschungszentrum Jülich

RESOLVE

Resource-efficient lightweight seats

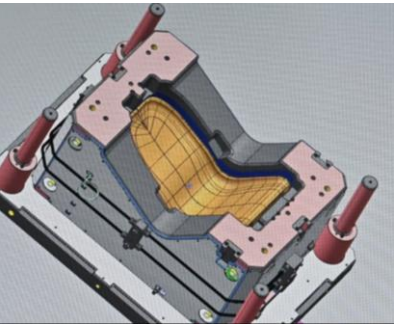
GOAL – Development and production of an innovative lightweight seat made from fiber-reinforced thermoplastic semi-finished products

RESULTS

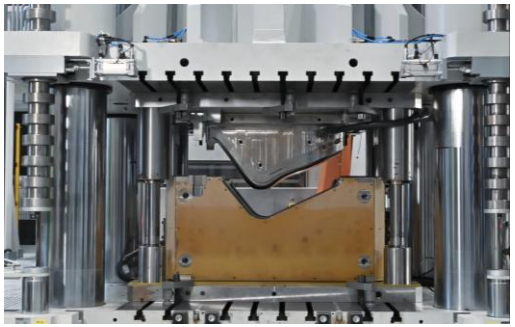
- Lightweight design
- **Significant reduction** in the number of individual parts
- Ergonomic design
- **Flame-retardant** properties
- High **recyclability** thanks to the use of thermoplastics
- **Cost reduction** due to single-stage production process

FACTS

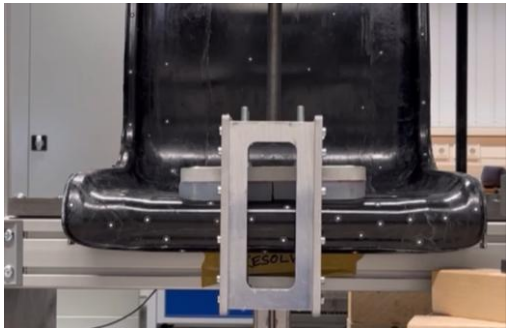
Single seat dimensions:	600 x 440 x 540 mm
Weight:	< 6 kg
Material:	PA-GMT
Flame retardant:	AKROMID B3 1FR
Pressing time:	< 50 s
Production costs:	< 100 € / Seat



Pressing Tool



Seat Manufacturing

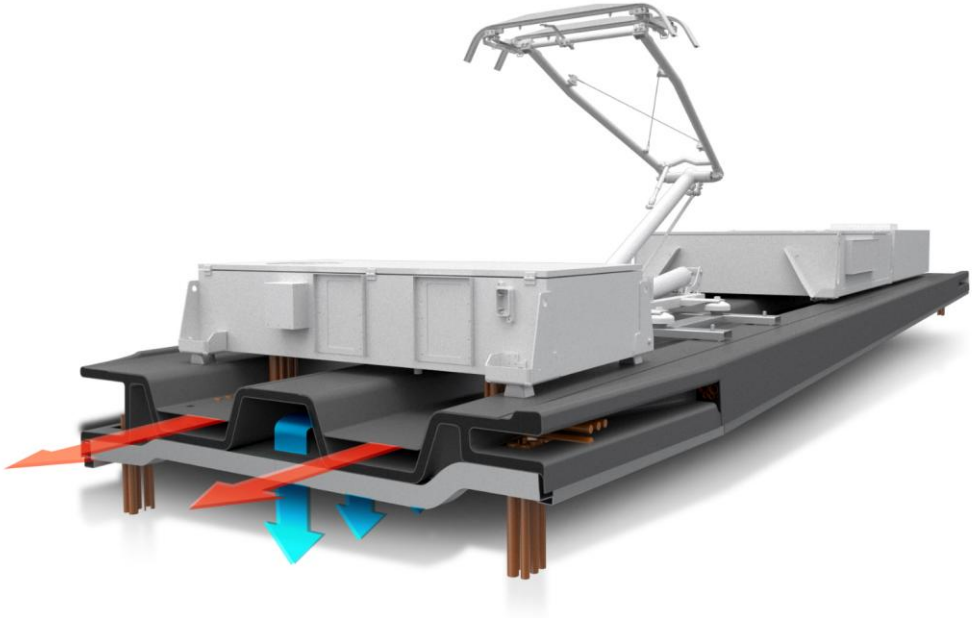


Static and Dynamic Seat testing

Seat Measurement using GOM

INTEGRAL

Innovative lightweight roof



-15 %
Cheaper than comparable steel roof

-45 %
Lighter than comparable steel roof

Research Partners:

Fraunhofer IWU

HeiterBlick
Assoziierter Partner

TÜVRheinland

ARNELL

RCS GMBH RAIL COMPONENTS AND SYSTEMS

Supported by:
Federal Ministry for Economic Affairs and Climate Action

INTEGRAL

Innovative lightweight roof

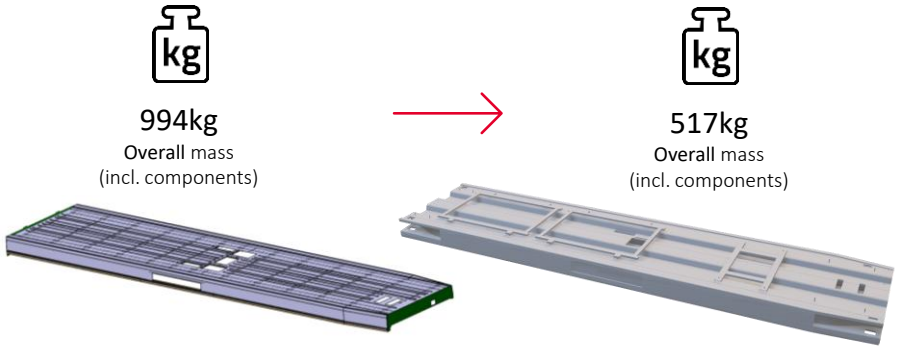
GOAL – Development and production of a lightweight roof with integrated functions for air conditioning and component fastening

RESULTS

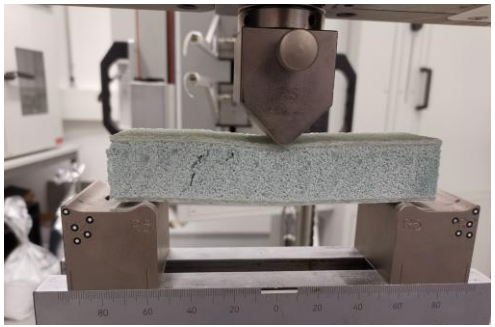
- Higher strength compared to a corresponding steel roof
- **Maximum load capacity** with minimal fatigue properties
- Economical roof structure suitable for series production thanks to efficient production technology
- Low **installation effort** due to integrated functions
- **Scalable** in length, width and height

FACTS

Material:	Fibre-reinforced composite material (GRP + Foam core)
Production:	Vacuum Infusion (VARI)
Fire Protection:	DIN 45545
Integrated functions:	Cold/hot air ducts cable ducts and cable glands Roof drainage Fastening elements for roof structure



Steel roof differential construction vs. Optimised sandwich roof integral construction

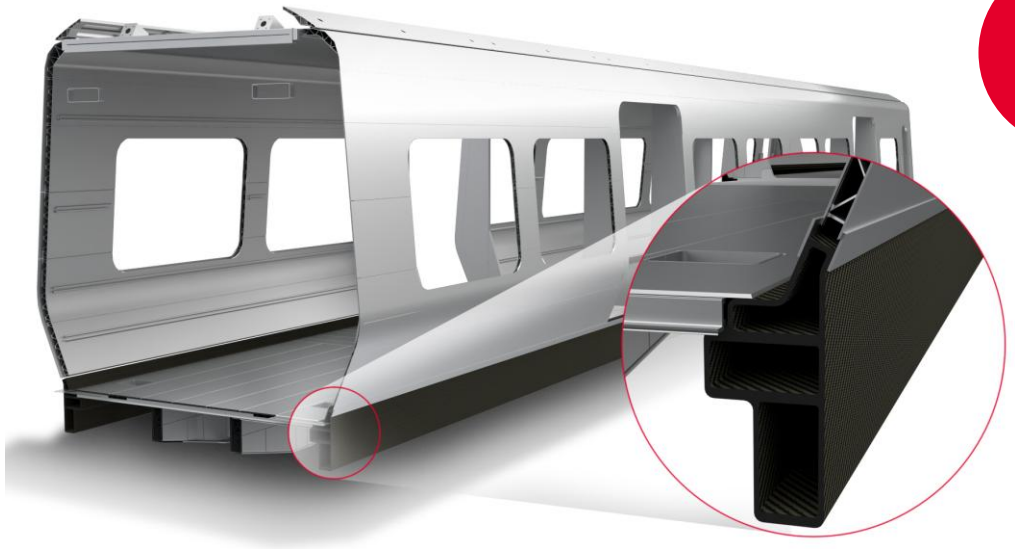


Load test

Fastening element metal insert

FUNPUL

New lightweight construction



-40 %
Lighter than comparable longitudinal beam

-10 %
Less Life-Cycle-Costs

Research Partners:

Fraunhofer IWU

FIBERCHECK

MAUS

MODE SPITZE PLAUEN GMBH

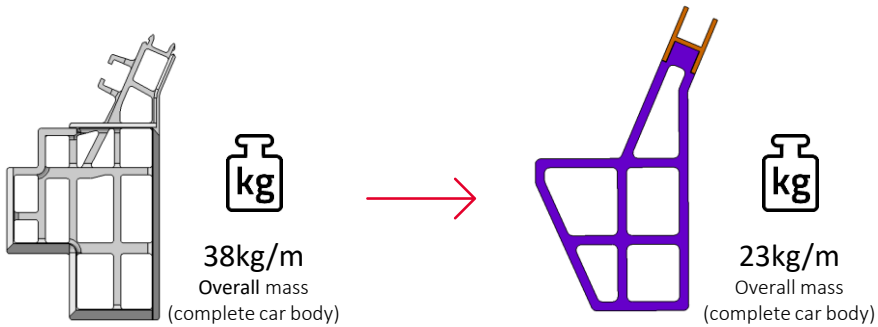
FUNPUL

New lightweight construction

GOAL – Development and production of a series-ready lightweight structure for railway vehicle underframes in CFRP pultrusion construction

RESULTS

- **Lightweight construction** with CFRP pultrusion profile
- **Scalable** in Length, width und height
- Economical manufacturing and assembly process suitable for series production
- Low **installation effort** due to integrated functions



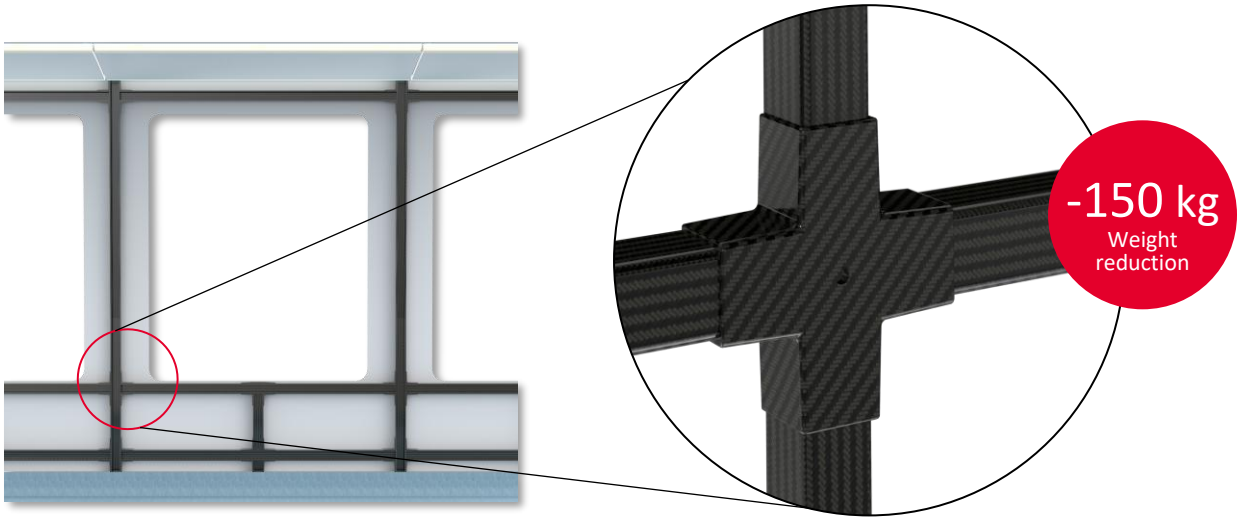
Comparison: Aluminum profile vs. CFRP-profile

FACTS

Material:	CFRP pultrusion profile incl. interface profile
Production:	single-stage manufacturing process
Fire Protection:	DIN EN 45545
Integrated functions:	Metallic interface on the part of the plastic profile Interface only allows two degrees of freedom Flexibility in the type of connection technology

PulPro-SMC

Lightweight construction with pultruded profiles



Research Partners:

Fraunhofer IWU

CONBILITY producing sustainability

Polynt

MODELLBAU ROTH

LSE

TÜVRheinland® Genau. Richtig.

PulPro-SMC

New lightweight construction strategy

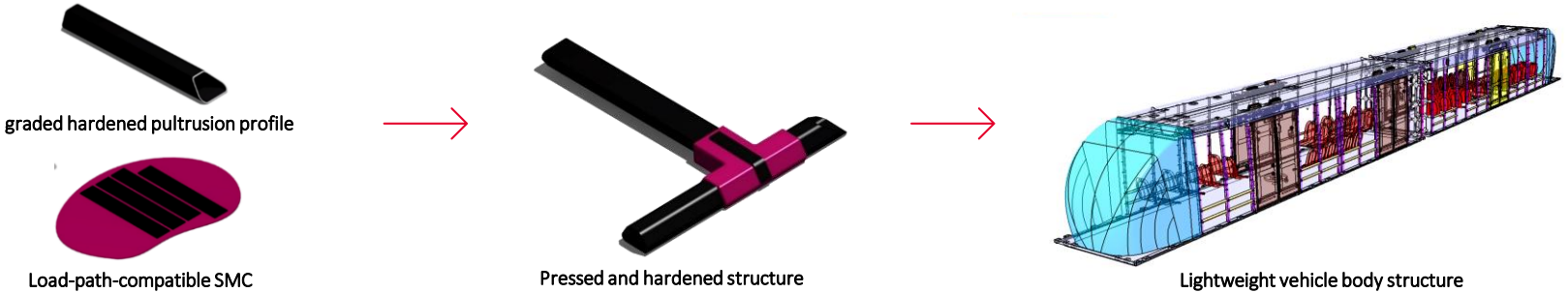
GOAL – Innovative lightweight vehicle body structure using a combination of pultrusion profiles and SMC-manufactured connecting elements

RESULTS

- Combination of FRP processes suitable for large-scale production - pultrusion and SMC pressing
- **Lightweight construction** thanks to FRP design
- **Force flow-orientated design** with maximum performance thanks to FRP
- **Direct material-locked joining** (without adhesive) and simultaneous formation of a node structure
- Wide range of design options
- **Sustainability** due to using recycled materials

FACTS

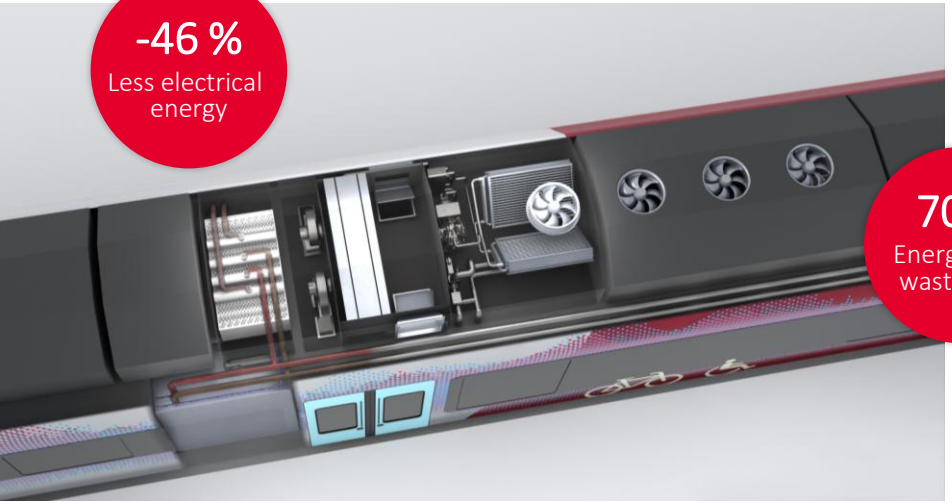
Material:	SMC – Sheet Molding Compound made from recycled CRFP and epoxy-based resin system
	TowPregs – impregnated CRFP-Rovings
Production:	single-stage manufacturing process
Fire protection:	HL2 R7 through additives
Price:	Economical thanks to standardised profile designs and modular system



Heat2Comfort

Waste heat based climatization system

-46 %
Less electrical energy



70 %
Energy from waste-heat

Research Partners: Fraunhofer IFAM, ILK DRESDEN, WÄTAS

Gefördert durch: Bundesministerium für Wirtschaft und Klimaschutz

TÜVRheinland® Genau. Richtig.

Heat2Comfort

Waste heat based climatization system

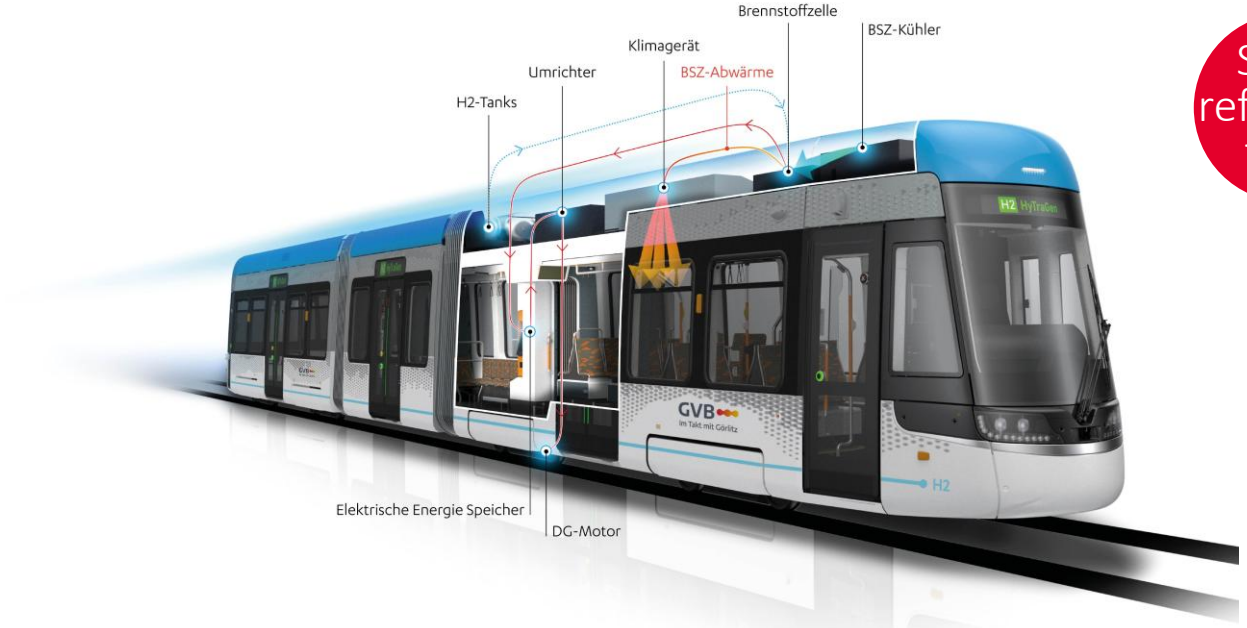
GOAL – Utilisation of fuel cell waste heat for indoor air conditioning and achieving thermal comfort

RESULTS

- TAIC – Thermal Active Interior Components and air conditioning system heat and cool the passenger compartment
- Effective use of fuel-cell waste heat for comfort-optimized climatization of the passenger compartment
- Significantly reduce the electrical energy demand for the compression chiller and fans
- Draught-reduced air conditioning

HyTraGen

The first H2 tram in Europe



Short refuelling time

Research Partners:

HeiterBlick

Leipziger Verkehrsbetriebe

FLEXIVA

ALF Alternative Fahrzeugantriebe

CVAG Chemnitzer Verkehrs-AG

GVB Im Takt mit Görlitz

Gefördert durch: Bundesministerium für Digitales und Verkehr

Finanziert von der Europäischen Union NextGenerationEU

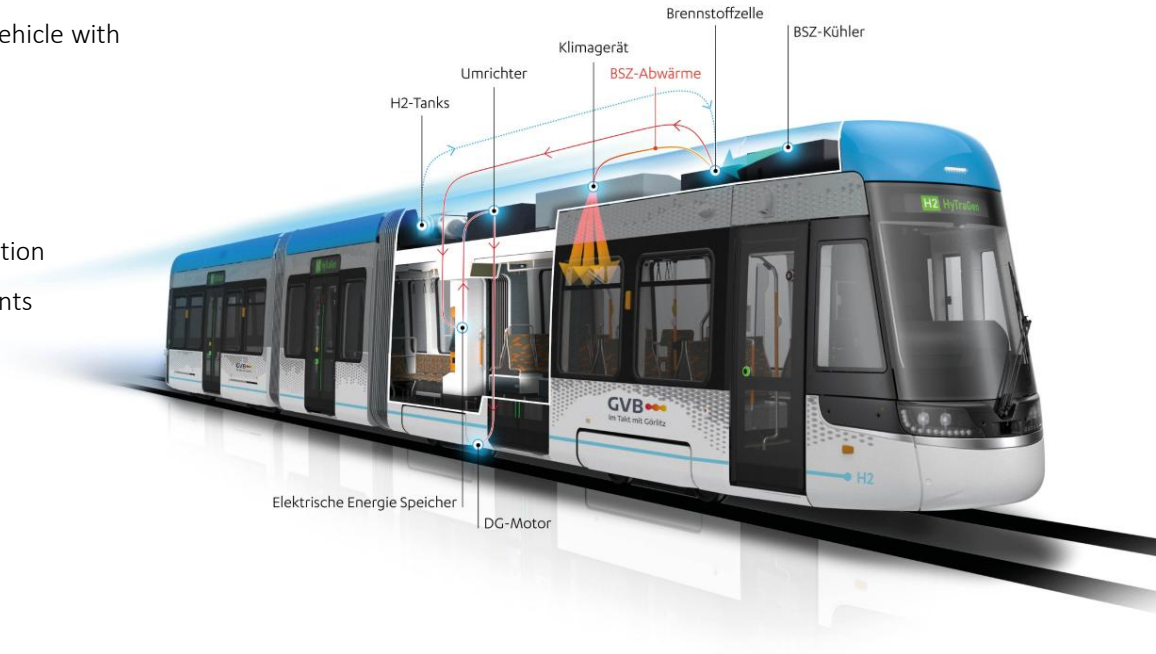
HyTraGen

the first H2 tram in Europe

GOAL – Development and production of an approvable test vehicle with testing under real operating conditions

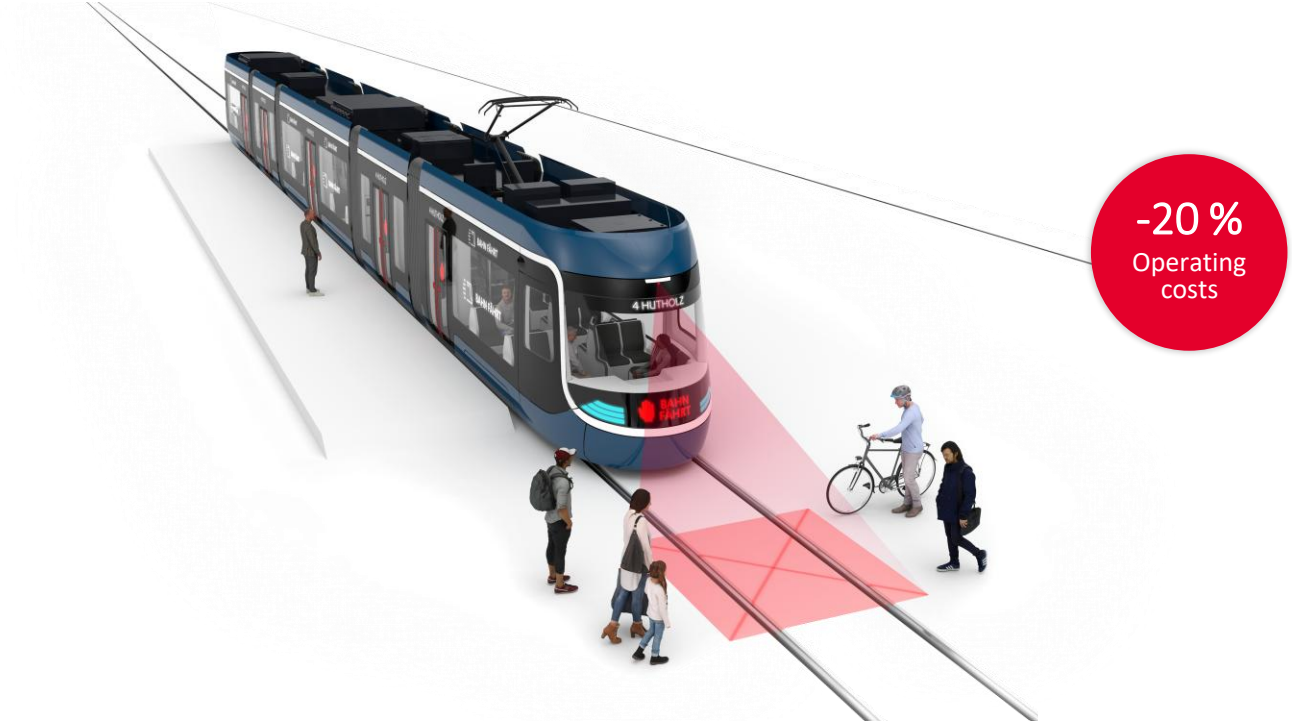
RESULTS

- Proof of function and validation of hydrogen drive systems
- Efficient energy management system and waste heat utilization
- Optimum arrangement of the additional H2 drive components
- Development of a hydrogen refueling and storage concept
- Functional safety solutions for fuel cell trams
- Derivation of certification requirements for fuel cell trams



SmarTram

Autonomous tram



-20 %
Operating costs

Research Partners:

IABG

FusionSystems

CHEMNITZ KULTURHAUPTSTADT EUROPAS 2025

Finanziert von der Europäischen Union
NextGenerationEU

Gefördert durch:
Bundesministerium für Wirtschaft und Klimaschutz

SmarTram

Autonomous tram

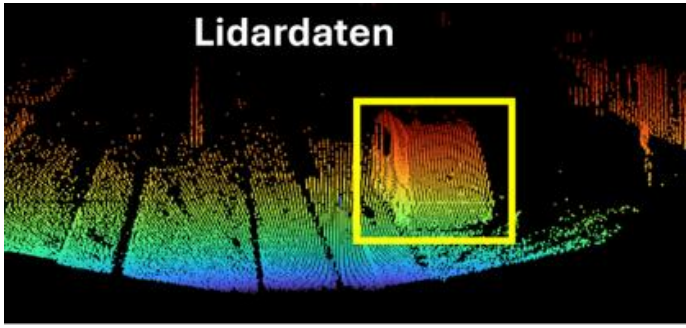
GOAL– Investigations into the integration of vehicle sensors and infrastructure data for autonomous operation (GoA 4)

RESULTS

- Analysis of operating scenarios, requirements specification
- Concepts for vehicle interfaces, sensor technology and communication
- Design of a system architecture including infrastructure components
- Development of hardware and software modules that enable autonomous operation of future vehicles
- Test drives to train the sensors and determine the control parameters for driving with a Tatra T3M as test vehicle
- Development of a vision vehicle to demonstrate the potential (communication, ergonomics)

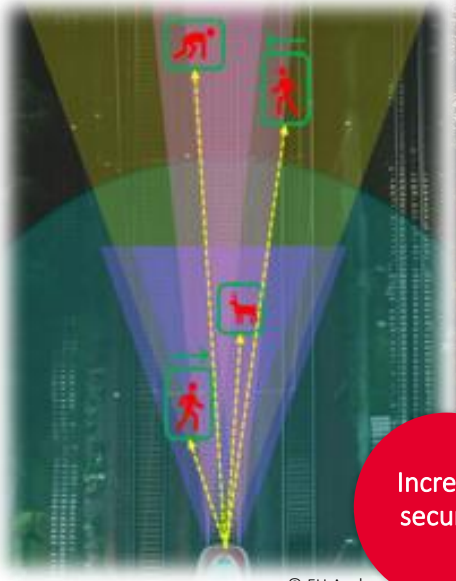
Test vehicle ,,Tatra T3M"with integrated sensors and control components

Visualisation for sensor control of a tram



RailAIxs

Rail Automation with Artificial Intelligence for detection of exceptional situations



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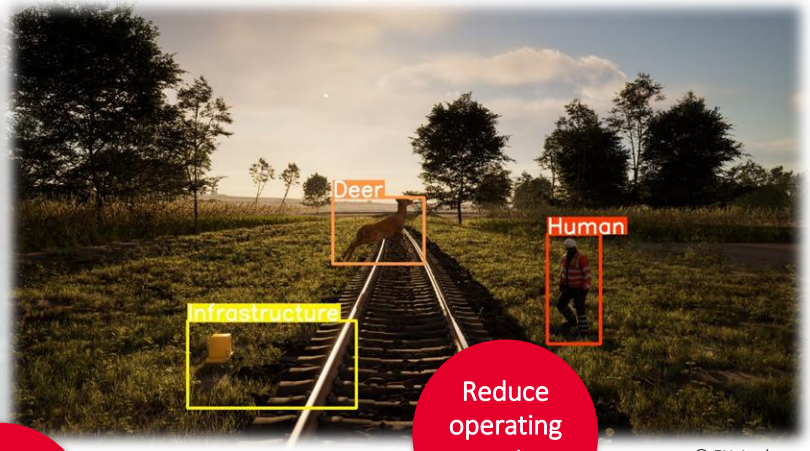
Increase security



Reduce operating costs

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Research Partners:

ifs Chair and Institute for Rail Vehicles and Transport Systems | RWTH AACHEN UNIVERSITY

MASKOR Mobile Autonome Systeme und Kognitive Robotik

QINUM

mFUND Das Startkapital für die Mobilität der Zukunft

Funded by: Federal Ministry for Digital and Transport

RailAIxs

Rail Automation with Artificial Intelligence for detection of exceptional situations

GOAL – Evaluation of the reliability of object detection and vehicle response on secondary routes

Development of approaches

- Approval-ready operation of AI-supported mainline railways on branch lines

Evaluation

- Selection, placement, and data fusion of sensor types with a focus on object detection

Successful test run

- Autonomous operation on the Rurtalbahn line

Test vehicle on the Rurtalbahn line

Interface to vehicle control

Visualization of recognized objects