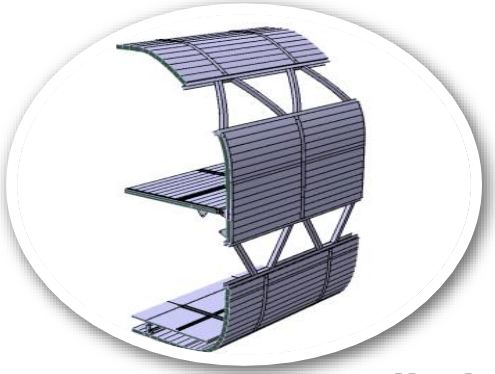
NEW MATERIALS IN RAIL

EXAMPLES OF LIGHTWEIGHT DESIGN

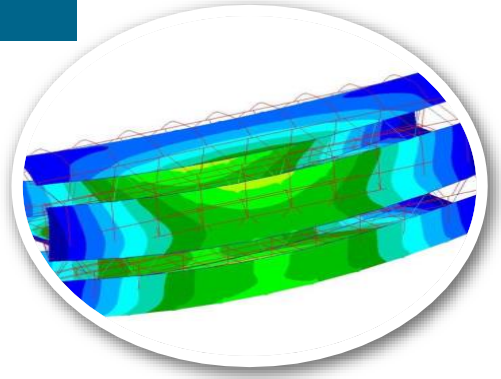
Marcel Andres
Institute of Lightweight Systems

Scope of in-house development opportunities at DLR

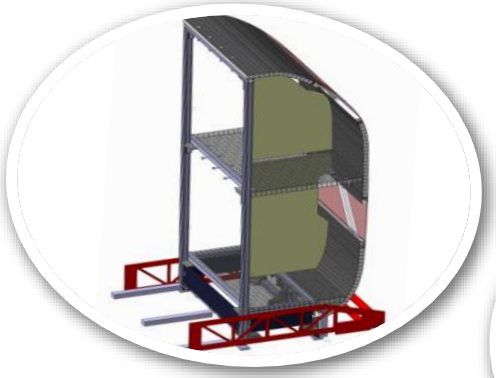
Typical Workflow



Preliminary draft



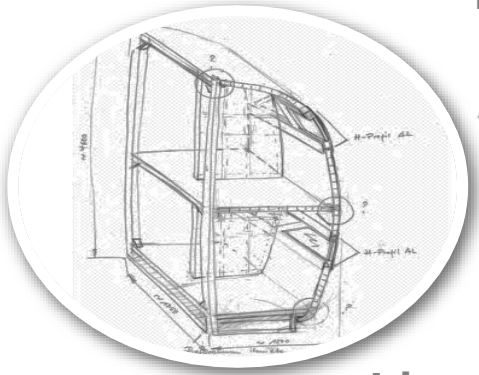
Computational Analysis



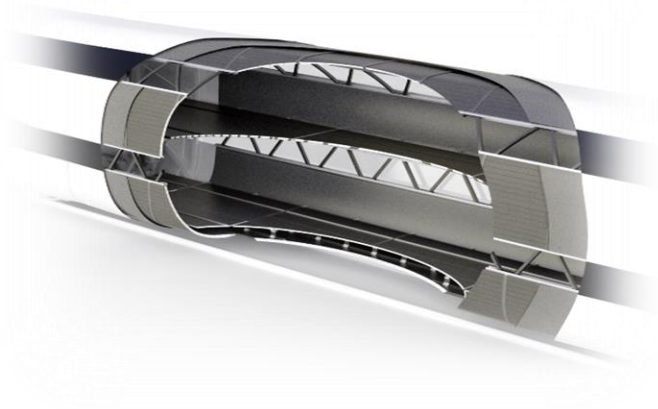
Final Design

Manufacturing

Final assembly



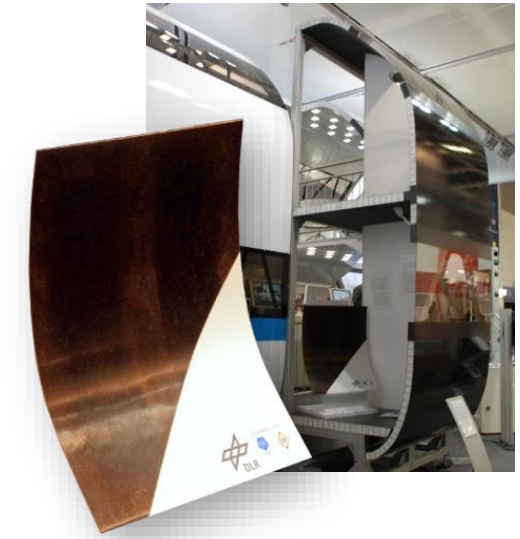
Idea



Overview of recent research activities

Topic selection

Sustainable Materials	H2-Storage Systems	Transfer



Sidewall demonstrator made from sustainable materials

Hydrogen pressure tanks developed by DLR

Transfer process via standardization by DIN [1]

Sustainable Materials in lightweight applications

Motivation and objectives

- Improving sustainability in the
  - **Production phase:** Reduction of the carbon footprint through renewable, regional materials
  - **Service life phase:** Reduction of CO2 footprint through lightweight construction and functional integration

Challenges

- Finding suitable 100% biological (resin, hardener and fibre) composites for (semi-)structural components
- Obtaining long-term experience under real conditions
- Lack of normative standards hinders the use of new materials

Selection of previous projects with bio-composites

Next steps using flax composites

Developments

- Application potential of flax composites as material substitutes for GFRP **successfully demonstrated** several times in the past
- Market-side material developments (flax) enable the acquisition of high-quality semi-finished products (fabrics, scrims, UD) on an **industrial scale**
- New material developments (matrix system) enable the use of a **bio-composite** with a significantly better eco-balance (up to 100% bio-composite possible)
    - More fire resistant thermoset (bio) according to **EN 45545-2** or infusible thermoplastic (recyclable) possible
    - **Better fatigue properties** than GFRP (critical load case) with lower density → Lightweight potential

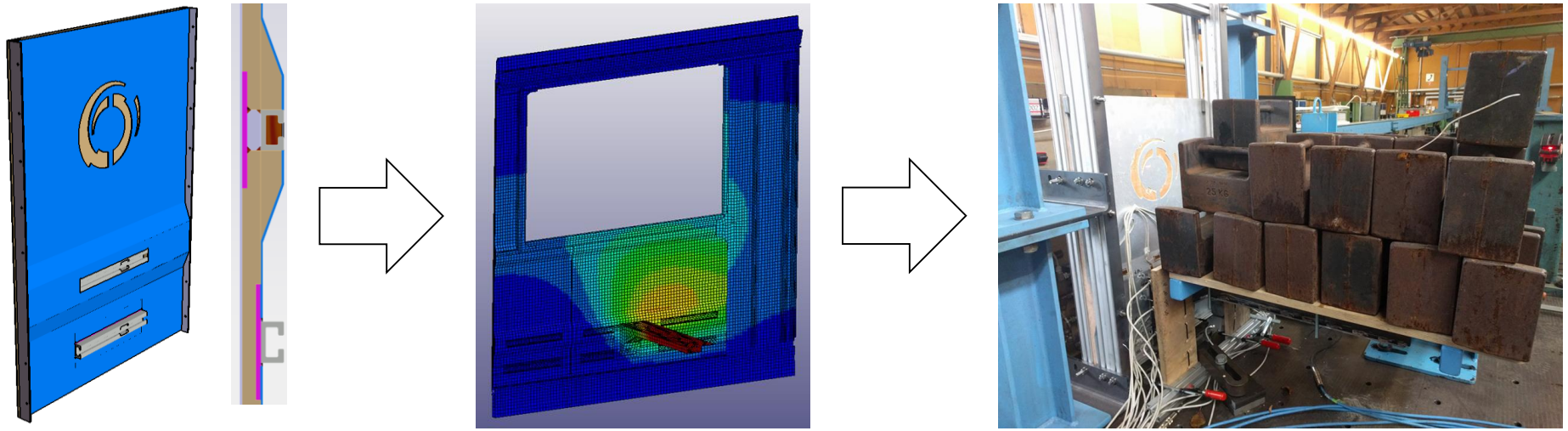
DLR, Design by Robert Hahn

Concept of the NGT-Taxi with a flax-fibre frontsystem

Flax composites available as woven fabrics / scrims [2]

Other sustainable materials - Wood

Sidewall segment of a tram

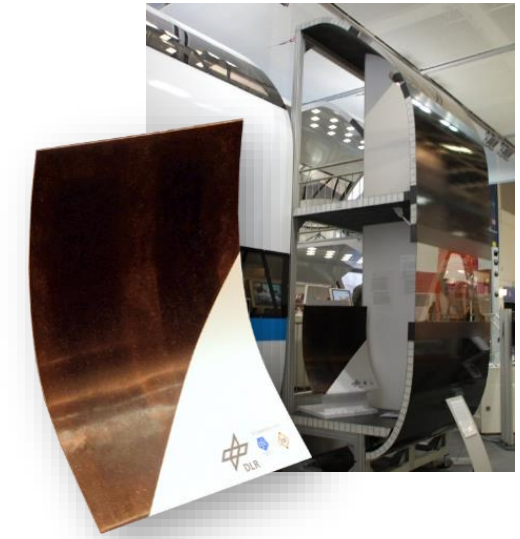


- Higher inherent stiffness & integration of insulation
- Weight reduction of up to 20%
- Slimmer design → More space in the interior

Overview of recent research activities

Topic selection

Sustainable Materials	**H2-Storage Systems**	Transfer



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Hydrogen pressure tanks developed by DLR

Transfer process via standardization by DIN [1]

H2-Storage Systems

Motivation and objectives

- Development of novel manufacturing concepts and design methods for H2 tanks incl. QA to create more reliable tanks
- Evaluation of remaining service life by SHM systems and extended fatigue strength concepts

Challenges

- Passing the certification tests
  - Bursting pressure tests starting next week
- Optimal refueling of the hydrogen tanks under consideration of the thermal load
- Ensuring impermeability after multiple loads

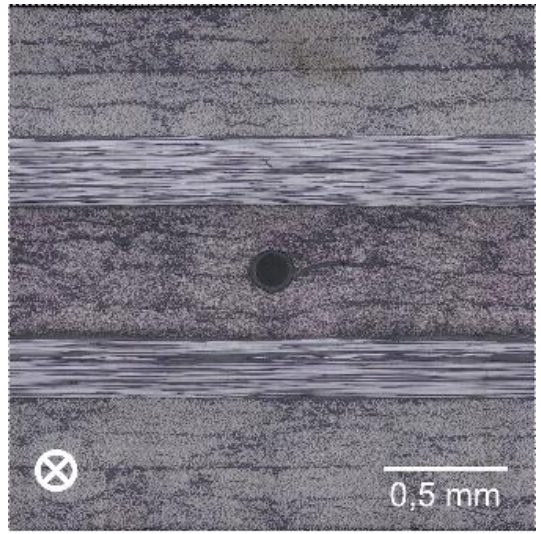
Hydrogen pressure tank developed by DLR

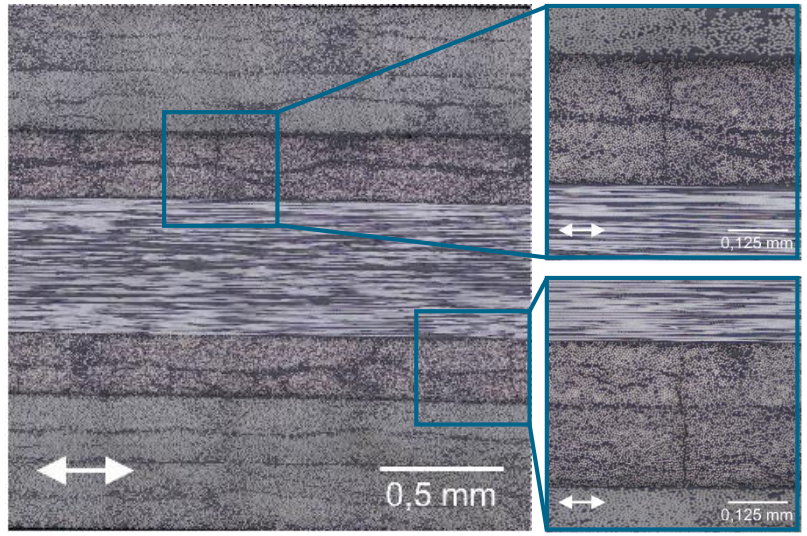
Investigating the leakage phenomenom

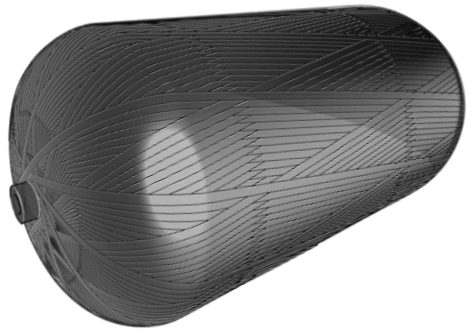
Test infrastructure

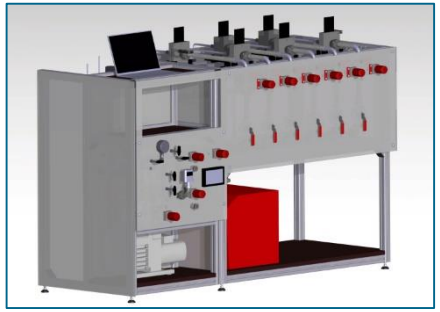
- DLR is currently building an extensive infrastructure for the investigation of hydrogen applications
  - Is largely driven by aviation
  - Knowledge can/should be transferred to the ground-based mobility sector
- First tests are showing higher permeability with higher pressures (tested from 1-10bar)

  For high pressure tanks (350-700bar) this might be critical in future
- Suitable design solutions and material combinations must to be found









Development of test rigs to measure the permeability of pressure tanks under different conditions

Overview of recent research activities

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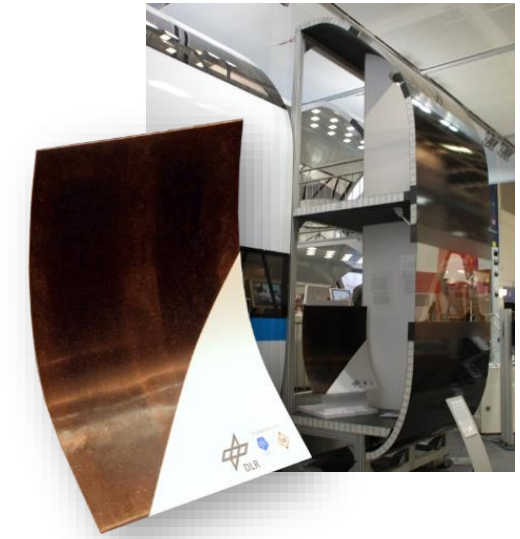
Sustainable Materials	H2-Storage Systems	**Transfer**



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Hydrogen pressure tanks developed by DLR

Transfer process via standardization by DIN [1]

Transfer and industrial cooperation

Motivation and objectives

- Collaboration with industry enables us to conduct application-oriented research
- The goal of any structural development is the use in practice

Challenges

- Honest insight regarding current challenges in the industry
- Lack of standards hinders use of new materials in rail transport
  - DIN SPEC about QA to be published in Q4/23
  - Participation in CEN/TC 256/SC 2/WG 54 - New Materials
  - Participation in many Hydrogen working groups

faWaSis as an example for a succesfull project with many partners

Imprint

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