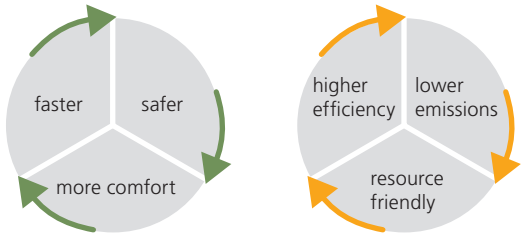
Challenges in rail transport:



According to: Federal Ministry for Economic Affairs and Energy
"New vehicle and system technologies"

In the White Paper on "Transport" (2011) the EU defined the goal to shift 50% of passenger transport from road to other modes of transport until 2050. The motivation is to reduce CO_2 emissions by 60% and thus to save fossil fuels. To achieve these goals, passenger rail transport has to become much more attractive.

In addition to fostering the attractiveness of rail transport, the efficiency of existing air-conditioning systems must be increased to reduce the overall energy demand. The air-conditioning system is the second largest energy consumer during a train journey, accounting for up to 30% of the total energy demand. Moreover, the regulation on fluorinated greenhouse gases 517/2014 results in further pressure for action in the rail sector in terms of investigating the possible use of alternative refrigerants in rail vehicles.

Furthermore, innovative concepts offer new possibilities with regard to digitalisation of rail traffic, promising great advantages when it comes to predictive maintenance, for example.

New DIRK project (start Q1/2021)

Single-seat air-conditioning of the passenger compartment using additional infrared panels

- Equipping the DIRK with infrared panels
- Reducing the average temperature in the passenger compartment
- Local, individual, demand-dependent reheating with infrared panels
- Objective and subjective evaluation of thermal comfort
- Energy demand analysis using duty cycle measurements
- Evaluation of the energy saving potential

DLR at a glance

The DLR is the Federal Republic of Germany's research center for aeronautics and space. Its extensive research and development work in aeronautics, space, energy, transport, security and digitalisation is integrated into national and international collaborations.

In the field of rail transport, the DLR is concentrating on its own research in the project "Next Generation Train". This project investigates a wide range of aspects such as aerodynamics, air-conditioning and comfort. In addition, the DLR is available as a partner for industry and joint research projects.

DB Systemtechnik at a glance

DB Systemtechnik, Europe's leading competence center for railroad technology, is the engineering office of Deutsche Bahn AG. With more than 950 employees at three main locations in Germany, the company provides highly qualified engineering services as well as approval management, testing and certification for all aspects of the rail system. DB Systemtechnik is the technology partner for railroads, planners, vehicle and component manufacturers throughout Europe.

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DLR Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

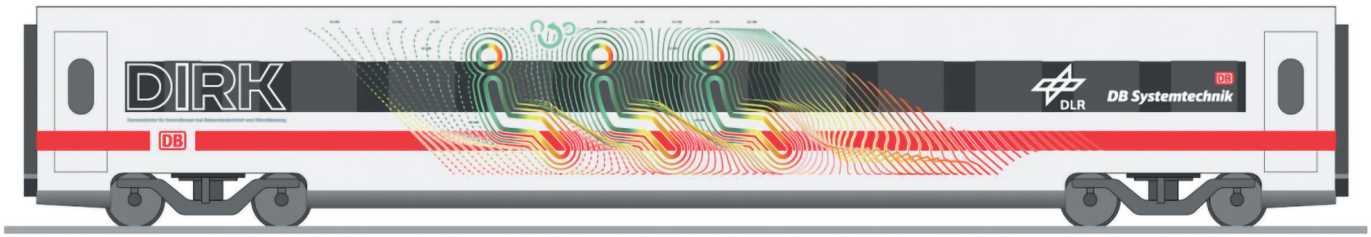
DB Systemtechnik

DIRK_ENG_03/2021

Demonstrator for Innovations in Passenger Comfort and Air-Conditioning – DIRK

DB Systemtechnik

DLR



Faster innovations thanks to DIRK:

- With DIRK we provide a stationary test facility for the development of innovations in travel comfort and air-conditioning systems of rail vehicles.
- Component tests can be carried out in an almost realistic environment without the risk and expense of testing on a moving train.
- The close cooperation between DB Systemtechnik (operational and application-oriented engineering and testing services in the field of rail vehicle air-conditioning) and the DLR (thermal manikins, latest measurement technology and innovative projects) promotes innovative solutions.
- Joint DLR-DB projects, the use within the framework of nationally and internationally funded projects and the possibility for third parties to use the facility offer completely new development steps in passenger comfort and air-conditioning.

The vehicle DIRK:

- Redesigned ICE car, type Bpmz 802.9, open car with 74 seats
- Total heating/cooling capacity: 50.9 kW/33 kW
- Location: premises of DB Systemtechnik in Minden, availability of the local climate chamber MEikE[1]
- Split unit with R134a as refrigerant

Permanently installed sensors in the DIRK test facility:

- Parameters of the air-conditioning system
- Energy consumption meter
- Air and surface temperatures
- Air velocity and humidity
- Air mass flows/CO_2 concentration

Additional measurement systems available in the DIRK test facility:

- Laser-smoke visualisation and flow field measurement technology (PIV)
- Infrared thermography and tracer gas analysis (age of air, ventilation efficiency)
- Thermal manikins
- Equivalent temperature (thermal comfort, ISO 14505-2)

Climatic chamber MEikE[1]:

- Climatic type tests, functional tests and energy consumption tests (duty cycle)
- Accredited test laboratory (ISO 17025)
- Size of the test room (L x W x H): 75 m x 5 m x 5 m
- Temperature range in the test room: -20°C to +45°C

[1] www.db-systemtechnik.de/prueflabore

◀ Thermal manikins for the experimental simulation of blockage and sensible heat release of seated passengers

Cooperation DLR – DB Systemtechnik

On March 19, 2019, the German Aerospace Center (DLR) and DB Systemtechnik GmbH (DB ST) signed a cooperation agreement for the DIRK project "Demonstrator for Innovations in Passenger Comfort and Air-Conditioning". An ICE car was transformed into a laboratory to investigate air-conditioning in trains. After the conversion, the partners have jointly been researching technologies to improve passenger comfort and to reduce the energy requirements for air-conditioning.

Research focus:

- Integration of novel components into real geometries (e.g., air-conditioning systems, fans, pipe systems, air outlets, seats, radiant heaters, dimmable/switchable windows, etc.).
- Investigation of new control concepts
- Energy consumption and comfort analysis of new innovative components/systems
- Comparison with reference systems
- Effects of the freely adjustable parameters of the air-conditioning system
- Evaluation with local sensors (see EN13129), visualisation and measurement
- Accompanying numerical flow and comfort predictions (Computational Fluid Dynamics)
- Subject tests to determine the subjective perception of thermal comfort

Subject tests on thermal comfort with individual app-based controllable infrared panels to generate local comfort zones