



# **DB Systemtechnik Activity Report 2022/2023**

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## Foreword

### Tradition meets innovation – setting the course for the future of rail transport

Throughout the world, rail is regarded and promoted as a sustainable means of transport, and is being used by an increasing number of customers. Establishing reliable transport capacities in the system requires innovative solutions, robust technology and condition-based maintenance.

It is precisely in the interaction between the different components of the railway system that we use our many years of experience to develop innovative answers and actively shape the future. To give just two of many possible examples: our ETCS solutions for existing vehicles and our developments in the field of infrastructure monitoring.

We are supporting the rollout of ETCS with our all-round carefree package. This covers everything from ETCS consulting and feasibility studies concerning the conversion and retrofitting of existing fleets through to new approvals and risk and safety management. We offer all services from a single source in an economical setup and in cooperation with system suppliers.

Our infrastructure monitoring solutions provide you with continuous information to help detect and avoid potential problems at an early stage. We tailor our monitoring solutions for tracks, overhead lines and structures to precisely suit your requirements: whether you need a single system or a comprehensive all-in-one solution, DB Systemtechnik's monitoring solutions offer you every option.

As usual, this report gives you insights into our diverse areas of activity. The successes we have achieved would not be possible without the commitment of our employees, the trust of our clients and the collaborative support of our partners. For that I would like to say a big thank you!

**Yours, Hans Peter Lang**

Chairman of the Board of Managing Directors  
DB Systemtechnik













## **Selected projects DB Systemtechnik**



## Measuring the **aerodynamic load of** freight wagon superstructures



The superstructures of freight wagons sometimes experience considerable loads in exposed locations such as bridges due to natural air flows – especially crosswinds. For this reason, DB Cargo Denmark commissioned DB Systemtechnik to carry out corresponding studies on freight traffic over the Great Belt Bridge.

To enable measurement of the aerodynamic load, freight wagons were equipped with autonomous wind measuring technology. This was used to record the air speed (composed of relative wind and naturally occurring (cross) wind) and other measured variables (train speed and location, ambient conditions) completely automatically or remotely during the scheduled journeys of a regular freight train. For several weeks, this train crossed the bridge four times a day, the data being evaluated by remote control and access.

The amount and direction of the naturally occurring wind and the relative wind were separated by calculation.

The measurement results now available form a basis for the evaluation of fleet-wide aerodynamic loads, as well as for further discussion at European level with regard to infrastructure safety.



# Extension of test intervals for the ultrasonic testing of carrying axles

Short inspection intervals for axles represent a severe limitation of vehicle availability and lead to a disproportionately high workload for maintenance resources and infrastructure.

DB Regio was able to extend the intervals for ultrasonic testing on the carrying axles of one class of vehicles. The necessary examinations and documentation during ultrasonic testing, as well as the fracture mechanics calculations, were carried out by DB Systemtechnik. In addition, DB Systemtechnik supported the introduction of the procedure at the various maintenance locations and, among other things, created the test programmes on the mechanised ultrasonic testing systems (HPS systems). Thanks to the proven higher sensitivity of the test, it was possible to extend the test interval for the carrying axle under examination by a factor of 1.6 to 1.9 (depending on where the vehicles were being deployed). This avoids an additional delivery of the vehicles for the purpose of ultrasonic testing, thereby reducing costs for the client.

The approach used when extending short ultrasonic testing intervals (UT intervals) is to lower the detection threshold in the area of the axle relevant in terms of fracture mechanics. The probability of detection (POD) is determined for this purpose. For the POD, the entire test system is quantitatively evaluated in terms of its performance and application limits to demonstrate that a lowering of the flaw detection threshold is possible. The steps necessary for introducing the reduced flaw detection threshold during ultrasonic testing of axles with a longitudinal bore were implemented by DB Systemtechnik.

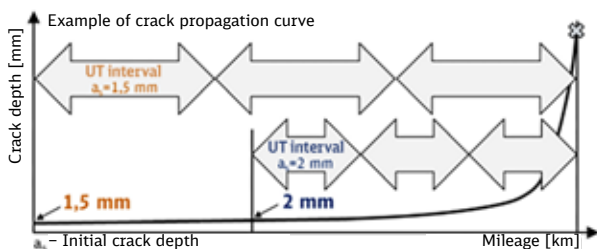


Fig. 2: Influence of crack depth on residual kilometric performance and the UT test interval



Fig. 1: Example of an axle inspection on the vehicle using a mechanised ultrasonic testing system

One requirement for the introduction of the lower flaw detection threshold is a crack propagation calculation using the reduced initial crack depth. On the basis of the crack propagation curve shown as an example in Figure 2, it is clear that a lower initial crack depth results in a higher residual kilometric performance. The inspection interval is derived from the residual kilometric performance, taking a safety margin into account.

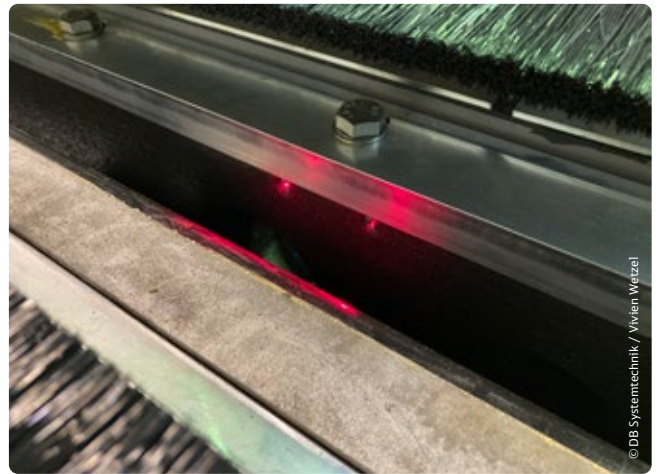
The initial crack depth (e.g. 1.5 mm), which is included in the crack propagation calculation, must be reliably detected later with the inspection system. The fracture mechanics calculation determines in which area of the axle the detectable initial crack depth must be confirmed (see Figure 3) and what kilometric performance then remains.

The lowering of the flaw detection threshold can only be applied to mechanised ultrasonic testing (HPS systems).

Fracture mechanical critical area / lowered LOD



Fig. 3: Areas with a lower detection threshold to extend the UT test interval



## Wheelset measuring systems contribute to digital maintenance

The digitalisation of vehicle maintenance is a crucial element for coping with the decarbonisation of transport. Increasing transport volumes, demographic change and a complex human resources market are leading to a constant shortage of maintenance personnel. The use of automated wheelset measuring systems is already making a considerable contribution towards saving these resources and is to be rolled out further in the future. The contractual basis for the procurement of 14 additional ultrasound/light section/measuring beam facility wheelset measuring systems (Argus II manufactured by Hegenscheidt) was established in 2022 as part of the DiFa digitalisation project. In the first quarter of 2023 four systems were accepted by DB Systemtechnik at the system manufacturer's plant and subsequently installed at the Hamburg, Frankfurt, Dortmund and Plochingen sites.

Another five wheelset measuring systems are scheduled for introduction in 2024. The maintenance technology experts at DB Systemtechnik are supporting these projects with technical expertise in the areas of machinery and metrology. The technical acceptance procedures, such as the functional test at the contractor's premises, the technical approval of the machines and the final acceptance test, are carried out by experts at DB Systemtechnik. The metrological approval of the systems was conducted in accordance with DIN 27201-9 by the DAkkS-accredited calibration and testing laboratory for rail depot measuring and testing equipment operated by Deutsche Bahn.

On completion of the planned projects in 2024, DB Regio will operate a total of five systems and DB Fernverkehr eleven systems at the largest maintenance locations. With regard to the digitalisation of maintenance in our depots, this is another step towards overcoming tomorrow's challenges by using innovative technology.





# Condition-based maintenance boosts efficiency: application example at DB Cargo

**A conversation with Daniel Kusch (Maintenance Systems Expert) and Markus Zimmermann (Team Coordinator, Processes and Regulations).**

Condition-based maintenance (CBM) is a strategy whereby maintenance is carried out on the basis of the actual condition of machines or equipment in order to extend their service life and minimise unplanned downtime. Currently, a lack of predictability in maintenance planning, rising maintenance costs, very complex conventional regulations, a lack of structures and unclear specifications and processes all represent obstacles to the implementation of CBM and predictive maintenance (PDM). DB Systemtechnik is therefore providing support with an end-to-end approach to establishing CBM or PDM in maintenance processes. Together with DB Cargo, our experts have been working closely on this topic.

***Can you explain condition-based maintenance and predictive maintenance in more detail?***

**MZ:** Condition-based maintenance and predictive maintenance are two closely related concepts. Condition-based maintenance continuously records and evaluates vehicle data during operation in order to determine the current condition of vehicles and components. This allows maintenance to be carried out as required and maintenance intervals to be adjusted accordingly. The aim is to better understand the condition of the components and systems

in order to carry out maintenance in a targeted and efficient manner.

Predictive maintenance goes one step further. It is also based on the evaluation of data but aims to predict future problems and failures even before they occur. This is where modern technologies such as machine learning and artificial intelligence are used to detect patterns and anomalies in the data and to identify impending malfunctions at an early stage. This allows maintenance to be more predictive.

***In practice, the implementation of CBM applications in established corporate structures and processes is described as demanding. What difficulties can arise here?***

**MZ:** Implementing CBM applications in established companies can indeed present some challenges. A key aspect is the lack of experience in this area, as it is a comparatively new and innovative maintenance strategy. This means that companies often have to learn from scratch how to integrate CBM effectively into their existing processes and structures. But, of course, we can help with our expertise and experience we have gathered. Another issue is the lack of clarity regarding the applicable regulations and standards for the transition from conventional maintenance to data-driven maintenance. In this respect, companies have to do a lot of pioneering



**Markus Zimmermann (MZ)**

Implementing CBM can be challenging. Markus Zimmermann therefore relies entirely on the performance-enhancing effect of coffee. He is also considering CBM and predictive maintenance approaches for his coffee machine..

work to convince others and gain the necessary support and approval both within and outside of the company.

***That sounds like a really challenging task. Can you give us an example of how a company can overcome these challenges?***

**MZ:** One good example is DB Cargo, which has taken on the challenges of data-driven maintenance. They have launched several projects to integrate CBM applications into their corporate structure. In the process, they also entered into partnerships with external companies, such as us, to develop a generic procedural model for implementing CBM applications and for providing IT safety cases.

DB Cargo defined clear project targets at an early stage and collected ideas for possible use cases. Attention was paid to both the sensitivity of the components and the data-driven approach. The project was implemented in several phases, from setting targets, defining the system and selecting standards through to development and implementation. Safety aspects were also given careful consideration and the project was developed in close consultation with depots and component manufacturers.

***That sounds like a promising strategy. Are there any concrete examples of applications for condition-based maintenance at DB Cargo where we have provided support with our expertise?***



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**DK:** Yes, of course. One actual example of condition-based maintenance is the maintenance of the diesel particulate filters (DPF) in the Class 261 and 265 locomotives at DB Cargo. Previously, the data on the DPF was read out manually every 22,500 km during the Nachschau in-service inspection (IS 200) in order to monitor the degree of clogging and replace the filter in good time. In future, the relevant data will be read out continuously and automatically.

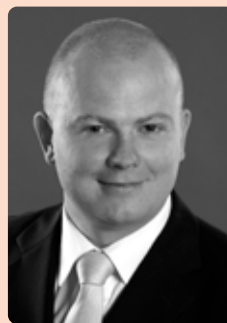
***That sounds interesting. How does it work exactly?***

**DK:** We used to read out the data via the serial interface using a service notebook in the depot. Now a telemetry box is connected to the DPF, which sends the data automatically. The degree of clogging is determined by an algorithm and displayed in a dashboard. This way we know exactly when a filter change is necessary to keep the traction unit in optimal condition. If a limit value is exceeded, the algorithm automatically generates a malicious code that is added to the worklist of the respective locomotive in SAP ISI. The filter is then replaced the next time the locomotive is scheduled for the workshop.

***That sounds like a real improvement. What tests and examinations have been carried out so far?***

**DK:** Together with the team of DB Cargo, we have conducted various studies and tests to ensure the safety and effectiveness of the new procedure. These include evaluating the current limits, parameters and specifications of the DYNTEST (test/measurement system for determining





**Daniel Kusch (DK)**

The first steps have been taken in the field of CBM – the topic offers a lot of potential and Daniel Kusch is looking forward to exploring and implementing it even further. Materials management is one exciting aspect among many that need to be further explored in this context and adapted to CBM requirements.

particulate deposits and burn-off in the particulate filter), defining the limits and parameters for the algorithm as well as the evaluation of the results in consultation with the vehicle and filter manufacturers.

***That sounds like a thorough job. And what about safety?***

**DK:** Safety is of course a key aspect of this project. Within the scope of the study, we evaluated and verified the intended change with regard to its effects on the safety of the system according to the process and the specifications of DIN EN 17023. The process described in DIN EN 17023 is the basis for changing the maintenance limit intervals and must always be applied and adhered to. The good news is that the planned change has been classified as non-safety-related, which means that it does not pose any risk to safety.

***That is reassuring to hear. Are there any other steps that need to be taken?***

**MZ:** Yes, of course. The task now is to validate the new automated read out and evaluation of the data in the upcoming project phases in order to further optimise the rule-based condition assessment of the diesel particulate filters. We will also use the feedback loop to identify and implement possible improvements.

***So there is still a lot of work to do. Can you describe the collaboration in this project in greater detail?***

**MZ:** Collaboration plays a crucial role. We work closely with various business units, including DB Fahrzeuginstandhaltung Cottbus, DB Cargo and the DB Cargo maintenance depot. Each area contributes its expertise and competency to ensure that the project is successfully implemented. We always achieve the best results when we pool our knowledge.

***Thank you very much, Mr Kusch and Mr Zimmermann, for these enthralling insights into the project. It sounds like a promising innovation that will significantly improve the maintenance of DB Cargo locomotives.***

**MZ:** Thank you, it was a pleasure to discuss it with you. I am confident that this project will have a positive impact on the efficiency and reliability of our locomotives.

***We wish you continued success in implementing this project!***

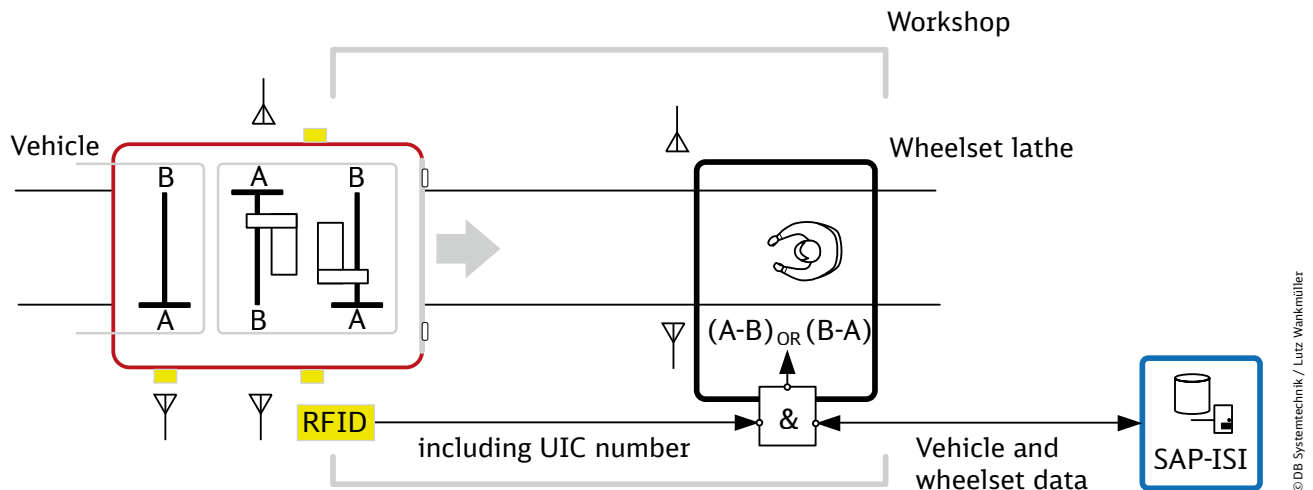


Fig. 1: Principle regarding the automated recognition of lateral assignment

## Bye-bye wheelset side assignment errors – automated wheelset identification on lathes



Fig. 2: Antenna setup on a wheel lathe

Wheelsets for every type of vehicle are reprofiled in the course of maintenance on almost 50 wheel lathes in the Group. In this process, wear-related variances in wheel profiles are corrected with a high degree of precision by machining. The transfer of measurement data to the SAP ISI maintenance system is now almost entirely automated, making manual transcriptions no longer necessary. One source of errors in this process lies in reliably identifying which side of the wheelset is which, especially in the case of symmetrical carrying wheelsets which have no side-specific features. As a result, the measured data can be incorrectly assigned, leading in turn to implausible data in the wear analysis.

Using the tools from the Group's Tag4Trace project, a concept is being developed at DB Systemtechnik in Kirchmöser, Germany, that will enable the machines to automatically determine the lateral orientation. The special layout enables the direction of travel to be determined and transmitted to the machine at the same time. An industrial PC, already installed in the wheel lathe by the manufacturer, functions as an evaluation system. This establishes communication with SAP ISI and receives the data set belonging to the incoming vehicle with the mounting positions of all wheelsets. A logic circuit extracts the information necessary for the processing job, including alignment, and assigns the wheelset sides. Ambiguous input fields on the machines' operator display panels are simplified for ease of operation.

The concept is being piloted at the DB Regio maintenance depot in Plochingen, Germany. Implementation requires intensive collaboration with the functional departments involved within the Group and with the manufacturers of the machine and antenna system. The interfaces to SAP ISI and the Tag4Trace system in particular offer new possibilities for linking data.





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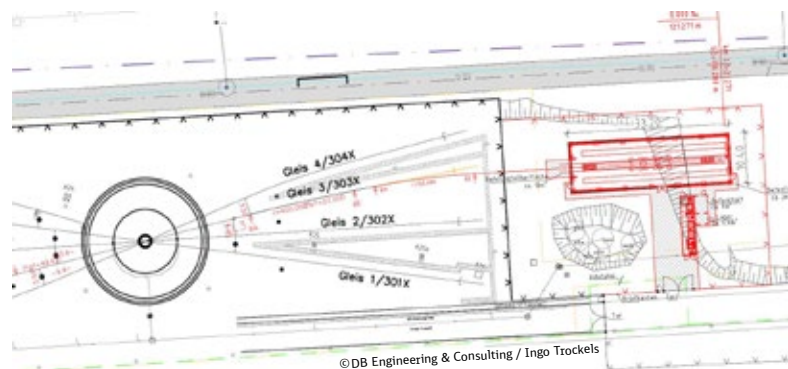
## A clean sweep – renewal of vehicle washing facilities for DB Cargo

DB Cargo is investing heavily to update the washing facilities for its fleet of locomotives. The first refurbished washing facility was commissioned at its depot in Seelze, Germany, in March 2023.

From the very beginning, DB Systemtechnik provided functional support for the project in terms of mechanical engineering planning. This included preparation of the project requirements specification, development of a functional statement of work for the demolition of the old and construction of the new washing facility, technical support for the contract award procedure and depot design as well as for the on-site acceptance and commissioning in Seelze. In addition to the refurbished washing equipment with its media supply, the new system technology now also includes an automated underfloor cleaning system, which means that vehicle underbodies will no longer have to be cleaned by hand in the future. The cleaning agent storage facility was converted to a new system that can be loaded by forklift trucks, avoiding

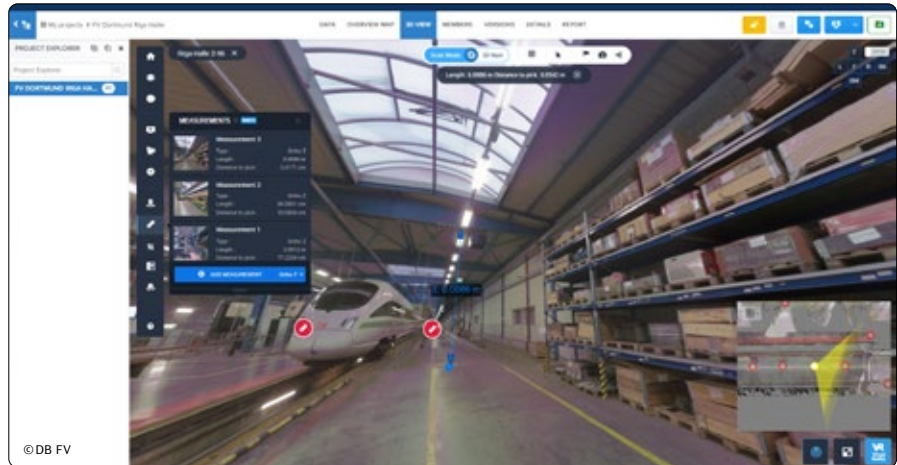
the previously time-consuming cleaning agent refilling processes.

Further projects are in the pipeline: in 2023, there are plans to upgrade the washing equipment for the exterior cleaning of locomotives to a state-of-the-art scope of functions in further DB Cargo depots in Cologne-Gremberg and Mannheim. In addition, the construction of a new state-of-the-art locomotive washing facility is planned at DB Cargo's new combined depot in Halle/Saale; commissioning is scheduled for 2024. In these projects, too, the experts from DB Systemtechnik in Kirchmöser are responsible for designing the machinery and wastewater treatment equipment.



© DB Engineering & Consulting / Ingo Trockels

Site plan for new DB Cargo exterior cleaning facility in Halle



# Digitalising reality – as-is assessment for depot design using 3D scanning technology

Rail vehicle maintenance depots are often located at sites that are rich in tradition and have been extended and refurbished time and time again. Under such conditions, as-built drawings are not always available in sufficient detail and quality.

The technology for surveying existing sites has developed rapidly in recent times, opening up completely new possibilities. The depot designers at DB Systemtechnik in Kirchmöser have determined the state of the art, piloted it and completed the chain of implementation in refurbishment projects. In combination with panoramic photos, 3D scanning technology was found to be ideal for the requirements in maintenance depots. The processing stages described below were executed in application projects in light and heavy maintenance depots.

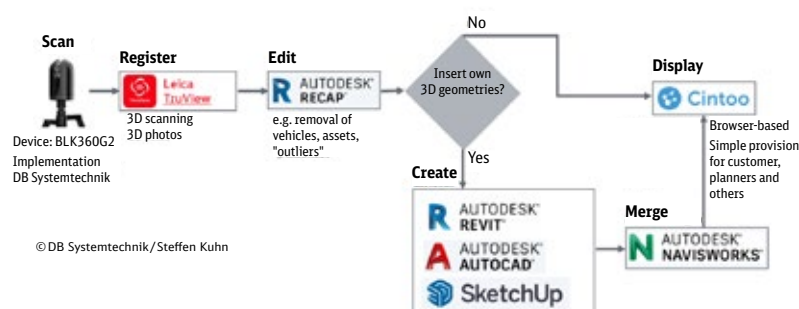
First of all, the geometry and an image of the reality on site are created using a 3D laser scanner.

In post-processing, the individual scans are combined, outliers can be eliminated and other functions performed, such as concealing the identities of personnel.

The results are made available for internal planning as well as for the project clients via a service that allows the results of the 3D scan to be walked through on any computer without the need to install applications, as is usual with map services on the internet, but in this case with an accuracy to within millimetres.

In the first months of application, for example, the following items were scanned: DB Fernverkehr maintenance depot in Dortmund, DB Regio maintenance depot in Mühldorf, engine test rig at the Bremen depot, several workshops at the DB Fahrzeuginstandhaltung depots in Krefeld and Paderborn, and DB Regio bus maintenance depots in Meldorf and Kiel.

Initially, the technology was intended solely as a design tool. However, customers have shown a great interest in direct access to the data and so the first projects have been implemented in which entire depots were measured and made accessible as a "digital twin" in a very short time. These will then be enriched with further information in the future.





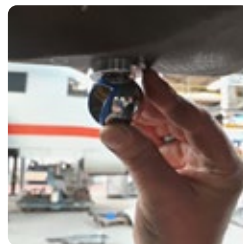
# Life-sustaining measures – precise measurement processes for a long service life

DB Fernverkehr is looking into extending the service life of ICE-1 trains to support long-distance services. For this purpose, the carriages and power cars of the current ICE-1 generation are to be extensively tested and those vehicles in good repair are to be overhauled for further use.

Class 810 to 804 vehicle bodies are being subjected to geometric inspections in the DB Fahrzeuginstandhaltung maintenance depots in Nuremberg, Krefeld and Neumünster. Class 401 locomotive bodies 401 series are being tested at the Dessau depot.

For this purpose, the almost 20-metre-long coach and locomotive bodies are brought into their prescribed reference position and measured using mobile 3D coordinate measuring instruments from Leica and Sokkia. The support structures, traction linkages, draw and buffing gear, traction motor mounts and the outer skin are measured using target marks and hand-guided reflectors.

DB Systemtechnik supports the maintenance depots in the selection of measuring instruments and tests the applied measurement processes under near-operational conditions using eligibility tests for the measurement



© DB Systemtechnik / Jonny Franke



process. A customised test concept was developed for each maintenance depot in order to separately determine the influences of the vehicle bodies themselves, of the prescribed reference position, of the depot conditions as well as of the definition and formation of the coordinate systems. In the course of these detailed studies, it was possible to identify and implement further optimisations and improvements of the measurement processes in a targeted manner in collaboration with the depots. This enables the maintenance depots to provide their customers with precise measurement results for assessing the quality conditions of the ICE-1 fleet.



## We pave the way to environmentally friendly air conditioning systems

Using natural refrigerants is one important way of reducing the environmental impact of heating ventilation and air conditioning (HVAC) systems and of future-proofing operations in terms of compliance with the EU F-Gas Regulation. As part of the TecEX "Fzg-HLK Natur" (Natural Vehicle HVAC) project, we therefore worked closely with the renowned HVAC manufacturer Merak to test and develop an innovative HVAC system using the natural refrigerant CO<sub>2</sub> (R744) and an integrated heat pump for efficient heating. In order to assess the suitability of this system and take a further step towards readiness for use, a field test was carried out and the results compared with a conventional R134a system.

The extensive sensor system and data collection (with 10,512,000 files and 500 signals per year per vehicle) required the construction of a robust data infrastructure. This infrastructure enables the efficient storage, visuali-

sation and analysis of large amounts of data. In addition, special dashboards were developed to monitor and analyse the actual state of the system, live and in detail, and to share it with all project participants. In conjunction with statistical analyses, this enabled an assessment of passenger comfort as well as an evaluation of the individual components in terms of their energy consumption and susceptibility to faults. The engineers were then able to identify opportunities for optimising the system. The customer will be able to use these findings to make further improvements to the efficiency and performance of the system. Through our participation in the field test and the evaluation of the CO<sub>2</sub> air conditioning system, we are contributing to the future introduction of environmentally friendly and market-ready technologies.



**Jörg Heland (JH)**

When Jörg Heland is not fine-tuning infrastructure monitoring solutions, he enjoys sports or playing guitar in a jazz band.



## On the track of progress – a look behind the scenes of infrastructure monitoring

### **A conversation with Jörg Heland (head of On-board Infrastructure Monitoring).**

Continuously measuring the condition of the track infrastructure in order to detect and avoid possible disruptions at an early stage and thus ultimately increase the punctuality of trains – does that sound too good to be true? DB Systemtechnik's infrastructure monitoring solutions actually make this possible. In Germany alone, more than 3000 km of track are currently monitored using these solutions. In addition to Germany and the UK, our systems are now also in use in Turkey.

#### **How did it come about?**

**JH:** Between 2015 and 2017, we optimised and metrologically approved the pantographs of the Siemens Velaro trains on the Ankara–Konya high speed line for speeds of up to 250 km/h in single and double traction. At the same time, we inspected the overhead line with our colleagues from Turkish State Railways (TCDD), prompting the idea of also collaborating on the regular infrastructure inspections.

***That sounds like an interesting collaboration. Can you tell us more about the continuous infrastructure monitoring (CIM) system that has been installed on the trains?***

**JH:** Together with the vehicle manufacturer Siemens, we installed the first CIM system in a regular train in Turkey. This system consists of an instrumented pantograph for overhead line measurement and a continuous track monitoring (CTM) system for simultaneous monitoring of the track geometry. What is special about these systems is that they work autonomously, i.e. without an operator, and continuously record measurement data while running. Really exciting!

#### **What happened after the introduction of the CIM system?**

**JH:** After a short period of time, the need arose for TCDD to approve further HSR route sections and to set up a train exclusively for measurement. The first Velaro delivered from Germany was selected for this purpose. In this train, some coaches were to be converted exclu-





sively into track geometry car. Optionally, these coaches can be locked if necessary and the train can be used to "strengthen the fleet" for passenger service.

***That sounds like a smart solution. Can you tell us more about the technology and data connection on the train?***

**JH:** In 2022, together with Siemens Turkey, we planned the retrofitting of the equipment and the data connection on the train to an "IT backbone" developed by Siemens. The aim of this central networking of all measuring systems was to facilitate data transfer to the "land side" and, for homologations, a "quasi-online" display of the measurement results for the technicians on the train. The measurement data for the engineers on board can be displayed and evaluated online on the train on centrally integrated dashboards. The project was implemented in the second half of 2022. This year, TCDD also ordered instrumented wheelsets from DB Systemtechnik to complete the measuring equipment on the train for track homologations.

***Thank you for giving us such comprehensive information. Are there any other exciting projects in the pipeline?***

**JH:** Yes, definitely! We can imagine further collaboration with our partners – for example, in the development of the HSR network in Egypt, which is being constructed by Siemens Mobility and operated by DB. What is more, we are in talks with DB Netz aimed at implementing some inspections with measuring instruments on regular trains.

## Calculating **vehicle dynamics** for a strong infrastructure



In the context of construction and refurbishment projects on DB lines, vehicle dynamics calculations are always required if designers cannot use the standard procedures due to construction-related or operational restrictions. In order to make the railway infrastructure in Germany as efficient as possible, such design work is becoming more and more common. The calculations must ensure that the necessary braking distances are nevertheless maintained. The client is usually DB Netz, and these are almost always state-funded projects.

Many different issues are affected, such as shortened warning distances that deviate by more than 5 % from the regular braking distance. Using conversion factors, a special braking chart is created for the reduced distance and the respective gradient, which indicates whether the regular trains can still maintain the desired speed or have to travel at reduced speed.

Another aspect of the calculations concerns gradual speed signalling, with which, for example, higher speeds can be maintained for longer before switch zones as the signals are not at the standard braking distance from one another, but are closer. The necessary braking distance is calculated for the respective speed reduction.

The vehicle dynamics calculations also include, for example, overlong entry paths (known as "late divergences"), in which the position is calculated of speed monitoring devices that trigger emergency brake intervention if the test speed is exceeded. The intention here is to reduce the risk of exceeding the permissible speed limit for the points to be negotiated as a result of an error by the train driver.

The calculations are often commissioned at short notice and are therefore also prepared within short timeframes in order not to delay the construction planning progress or even the commissioning. The respective question and the specific requirements are dealt with individually.



# Early warning system for transformers: oil analyses protect against damage and total failures

A number of DB Systemtechnik customers have suffered damage to their liquid-cooled main transformers. Some of these incidents are due to ageing or design and are therefore of a systematic nature, while others are sporadic individual defects. Many of these incidents develop comparatively slowly, so that if detected in time, the transformer can be replaced before a total failure. Prompt detection of incipient damage is very likely if transformer oil analyses are carried out at appropriate intervals. In addition to the routine tests (e.g. breakdown voltage, moisture, neutralisation number) according to DIN EN 60422 for mineral oils or DIN EN 61203 for synthetic ester oils, a gas-in-oil analysis according to DIN EN 61181 allows a more precise determination of the overall condition of the transformer.

Incipient damage in liquid-cooled transformers leaves traces of key gases in the liquid due to the energy input at the affected location. These gases vary depending on the cause of the damage and appear in increasing concentrations as the damage becomes more pronounced.

DB Systemtechnik operates a high-performance accredited laboratory for the analysis of mineral and synthetic transformer oils (routine testing and gas-in-oil analysis), employing experts to interpret the results of the analysis. The experts will make a recommendation for further action depending on the results of the analysis. The following options are available:

- Repetition of the test within a defined period (in order to assess the development of a trend)
- Recommendation for oil regeneration in the installed condition
- Examination with a supplementary measurement procedure
- Requirement to replace the transformer by a specific deadline
- Immediate decommissioning

Regular analysis of oil enables many unavoidable measures to be planned and handled in a way that is as compatible with operations as possible. At the same time, a measured value history is created for each transformer, which can be used by the experts for trend analysis.

In summary, transformer oil analyses by DB Systemtechnik enable early detection of damage to liquid-cooled main transformers, allowing prompt action to be taken to avoid total failures and to ensure safety and reliability.



Fig. 1: Preparation of platinum wire for measuring the interface voltage



Fig. 2: Determination of the breakdown voltage



Fig. 3: Measurement setup for gas-in-oil analysis

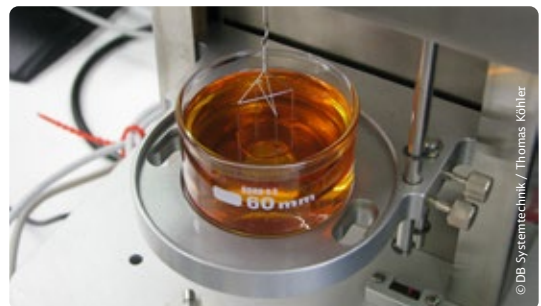


Fig. 4: Measurement of the interface voltage



## Innovative expertise in controlling climate comfort ensures a perfect tram experience

An exciting project in Frankfurt am Main shows how the experts at DB Systemtechnik have demonstrated their ability and expertise in taking the tram experience to a new level for the Verkehrsgesellschaft Frankfurt am Main (VGF) transport company.

Alstom is the tram manufacturer supplying Citadis trams to VGF. The operator demanded verification of the performance of the HVAC system to ensure that its comfort parameters comply with the standards. In addition, an assessment of energy efficiency for air conditioning was required, including proof of thermal insulation by measuring the heat transfer coefficient (U value) and annual energy consumption.

This is where our technical expertise came into play – we made sure that the trams met the appropriate standards to ensure passengers a pleasant ride. For this purpose,

our experts equipped the passenger compartments and one driver's cab with advanced measuring equipment and simulation systems in accordance with the relevant standards (EN 14750 and EN 14813). Three compact air conditioning units were also equipped with special measuring instruments for energy measurement in accordance with the DB energy consumption cycle 2013.

The team conducted extensive climatic chamber tests in the temperature range from  $-25\text{ °C}$  to  $+45\text{ °C}$  to demonstrate the efficiency and performance of the air conditioning systems. During the tests, the experts succeeded in optimising the control parameters of the air conditioning software.

As a result of this work, Alstom obtained proof of compliance with the standards and specifications.





## Increasing efficiency, reducing costs:

### Reducing the energy consumption of rail vehicles

In view of the significant rise in the cost of energy, increasing attention is being paid to the optimisation of energy consumption. Air conditioning systems are the second largest energy consumers on trains and are of particular significance in this respect.

Our experts at DB Systemtechnik have therefore devoted themselves to this very topic and developed innovative solutions to reduce energy consumption. Within the framework of reproducible standard tests in accordance with the energy consumption cycle, we have analysed the influence of two possible savings measures that are relatively easy to implement.

Reference measurements were carried out against the unchanged standard condition for a representative long-distance vehicle to allow comparison of the potential. Our method enables quick and accurate identification of the influence of various factors on energy consumption. This allows us to make swift informed decisions and improve our efficiency.

By using the DIRM demonstrator vehicle as a reference for the comparative measurements, we ensure that normal operations are not impaired in any way.

As well as greater efficiency, we also take thermal comfort into account, because in addition to optimising energy consumption, we still want to ensure that comfort on the train remains at a high level. Our efforts are aimed at making rail vehicles even more environmentally friendly and cost-efficient so that they make a positive contribution to sustainable mobility.

In this context, our findings can also be included as recommendations for action for the specifications of new vehicles as well as for the evaluation of possible adaptations of existing vehicles.



# Service notebooks help to improve vehicle availability and punctuality

The service notebooks are a project in collaboration with DB Systel under the leadership of DB Systemtechnik. Eleven depots, 970 notebooks and around 1,900 DB Fernverkehr employees benefit from the development, operations management and continued development of the service notebook system. In an interview with project manager Volker Küsel (VK), we find out exactly how this works. As part of an internal cooperation, work was also carried out on the error-free, complete and uninterrupted transfer of data to the Analysis Centre (ZAS). Subproject manager David König (DK) and data engineer Mario Pasculli (MP) provide additional information.

**DB Systemtechnik was commissioned by DB Fernverkehr. What services do the experts at DB Systemtechnik provide?**

**VK:** We have been commissioned with the development, operations management and continuous further development of the service notebook system.

Our solution will further improve the availability of the DB Fernverkehr fleet and thus the punctuality of the trains through increased IT & OT security, central updating and distribution of software for maintenance, automation and establishment of processes and IT service management for the operations management of the system with a customer hotline. In addition, IT service management is supported by a special software programme and includes, among other things, a 24/7 customer hotline which enables maintenance staff to contact the company by phone or e-mail at any time of day or night.

**We have often heard of the "service notebook" before. What is it actually?**

**VK:** The service notebook is a digital tool for software maintenance on rail vehicles. It can be used to load and configure software as well as to read out data. It is operated according to ITIL guidelines and offers a high degree of convenience and security in its use and operation. With this system we ensure that the latest software is available on all 970 service notebooks and can thus also be installed on all rail vehicles. This project therefore also has a decisive influence on the punctuality of DB Fernverkehr's trains.

**What challenges did you encounter during the project and how were you able to overcome them?**

**VK:** We certainly had a few. DB Fernverkehr's maintenance depots use software installed on notebooks for the maintenance of their rail vehicles. The software is subject to constant changes and must be updated according to the regulations.

The long life cycles of rail vehicles of around 30 years pose a challenge with regard to running service software, as this often only runs on operating systems that are no longer maintained. Action is therefore required to rule out any security loopholes.

The outdated operating systems with the service software are run on a current operating system with the help of virtualisation software (vmware). This programme creates what is called a virtual machine, in which the obsolete operating system runs with the necessary software.



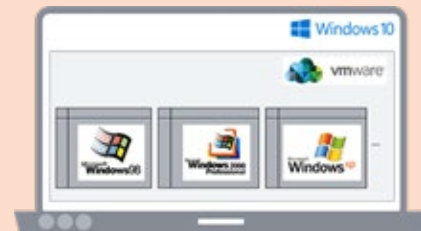
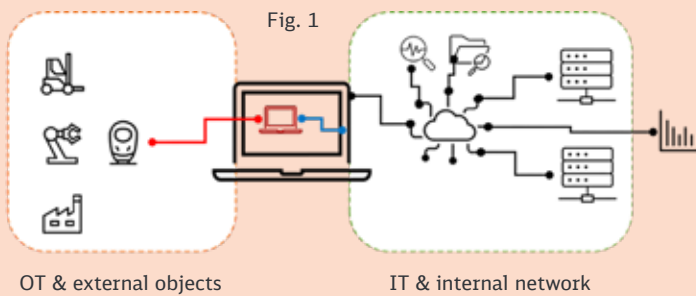


Fig. 2: Encapsulation of old operating systems on a current Windows 10 service notebook

© DB Systemtechnik (both Figures)

The software thus encapsulates the outdated operating system in virtual machines on a service notebook running a current operating system. This is how you solve the IT security problem.

***The service notebooks are also used for data transfer to the ZAS. What is this subproject about and what challenges did you face?***

**DK:** Very sensitive data, from the tachograph for example, must be transmitted in its entirety to the ZAS, without any gaps or errors. The previous method was largely manual using USB flash drives, group drives, etc. Other issues such as information security and data protection increase the demands on the system. Implementation is further complicated by bottlenecks in capacity among colleagues and a complex stakeholder structure.

***How have you resolved these issues?***

**DK:** We use the core service of the DB group's data management platform (DMP) as our technical basis. This maps our data storage and processing system in the cloud. Furthermore, special upload software for data transfer on the service notebook was developed in collaboration with the DSPECIALISTS company.

**MP:** The service notebooks transmit information to the DMP with regard to the data to be transmitted. Further-

more, information about data movements on the system is tracked on the DMP. ZAS also "acknowledges" the data received and deletes it from our system itself. This is due to the sensitivity of the data and the fact that the ZAS is the single point of truth for this data. Based on this information, services are provided such as an automatic consistency check, a dashboard and e-mail notifications in case of variances. The Azure Pilots team at DB Systel, namely Johannes Becker, also supported us in the development. Jürgen Schörnborn, our expert for vehicle diagnostics, supports us in the technical operations management of the data transfer.

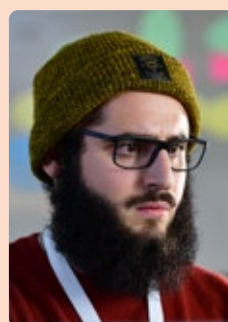
***What is the current status of data transfer and how does the roadmap look for the future?***

**DK:** The pilot phase at the Munich depot is now complete. The packaging has been finalised for the go-live at the Munich depot and is awaiting approval, accompanied by a maintenance notification (MN) for process-compliant implementation in the maintenance depot environment. This will be followed by a gradual rollout to all other DB Fernverkehr maintenance depots by the end of the year. At the same time, we are creating a concept for the transfer and processing of further data via the service notebook.



**Volker Küsel (VK)**

It is important to Volker Küsel to be able to play a role in shaping the future of the railway system in digitalisation and to create added value for our customers through sustainable digital solutions.



**Mario Pasculli (MP)**

As in his professional life, Mario Pasculli is also a technology enthusiast in his private life – the data engineer enjoys dabbling with smart home technology or electronic music.



**David König (DK)**

David König has learned in many projects that trouble-free project execution is an illusion. But with committed colleagues and innovative technology, it can be fun and successful.

## Platform safety – our contribution to the stability of weather shelters, stair enclosures and lift shaft frames



Weather shelters, stair enclosures and lift shaft frames are currently found on many station platforms, offering passengers protection from the elements. However, there is currently no uniform guideline for ensuring stability under aerodynamic load. This is where we come in, by taking measurements that can serve as the basis for an evaluation criterion.

Our team of experts have taken detailed measurements to determine the train-induced loads and reactions on the structures. Analyses were performed on compressive forces, air velocities, accelerations and deflections that occur when trains are passing. This data is crucial for assessing the stability of the structures and planning any necessary safety measures.

After the measurements were completed, a comprehensive report was produced containing a detailed overview of the data obtained and statistical presentations. It is important for us to focus on an easy-to-understand presen-

tation in order to make the results accessible to non-experts. In addition, the experts record the passing of trains in videos to facilitate an exact classification of the results and to be able to point out any special features in the statistics separately.

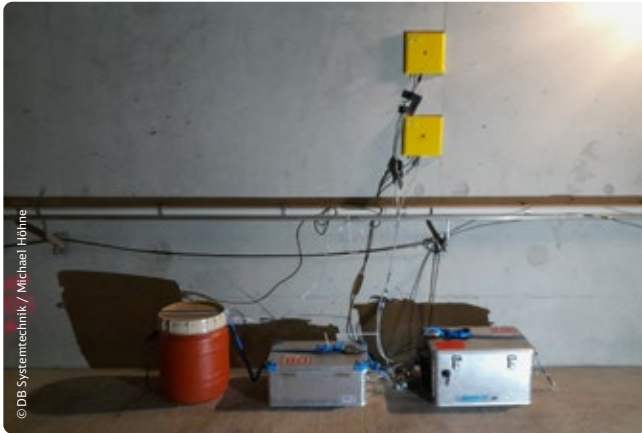
The measurements carried out and the planning of safety measures based on them create a strong foundation for platform safety. Our expertise helps to ensure that weather shelters, stair enclosures and lift shaft frames meet the stringent requirements of rail transport.

The measurements provide an accurate picture of the loads actually occurring on the structures. This creates the basis for appropriate dimensioning and ensures a reliable degree of safety on the platforms.

Our work thus forms an important basis for future guidelines to ensure platform safety throughout Germany.



# TSI measurements in tunnels – safety and efficiency for the Desiro HC



DB Systemtechnik attaches the highest priority to safety and efficiency in rail transport. We adopted this approach in connection with the TSI verification measurements for Siemens Mobility in the tunnel for the Desiro HC, which focused specifically on the aerodynamic loads on the infrastructure caused by train-induced entry pressure waves in tunnels. Increasing the operating speed of the Desiro HC requires proof of conformity in accordance with TSI LOC&PAS.

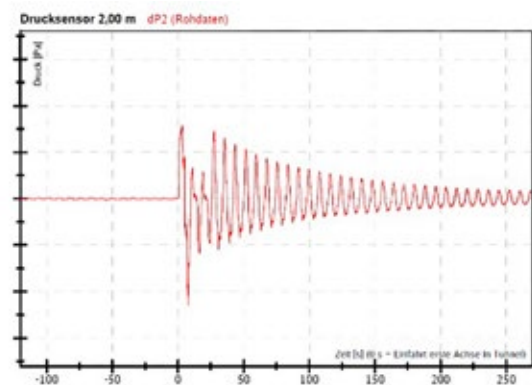
In order to assess the aerodynamic loads in the tunnel, the experts carried out TSI verification measurements by means of direct 1:1 measurements of train entries at appropriately installed measurement cross-sections. This involved the symmetrical installation of automated measuring instruments in both directions of travel of the sorting siding, at both the north and south portal.

By equipping both directions of travel with measuring instruments, we were able to reduce the required number of test runs by half. This not only saves time and money, but also minimises interruptions to rail services.

The symmetrical layout of the equipment enables reliable reproducibility of the measurement results between the north and south portals. This allows us to precisely assess the loads on the infrastructure and draw up targeted safety measures.

In addition to the measurement data, we use cameras to record the trains entering the tunnel. This information is crucial for uniquely identifying the measuring train in addition to the data regarding the number of axles, train

length and speed determined by track marks. It is also important in terms for recognising train and pantograph configurations.



The increase in the operating speed of the Desiro HC represents an important development in rail transport. Our contribution is to use precise measurements and modern technology to ensure the safety of this train and the stability of the infrastructure in tunnels. The TSI verification measurements are a crucial step towards providing proof of conformity in accordance with TSI LOC&PAS and thus enabling smooth operation of the Desiro HC.



## Efficient substitution of non-compliant energy measurement systems: advice from DB Systemtechnik for Group and non-Group vehicle keepers

**A conversation with Iven Billing (expert in the design of passenger transport vehicles) and Philipp Kölbl (project manager in the Engineering department).**

**Mr. Billing, could you please explain what significance energy measurement systems (EMS) have for locomotives and multiple units?**

**IB:** Of course. Almost all electric locomotives and electric multiple units have an EMS that transmits the energy consumption data to the grid operator. This allows a precise calculation of the energy costs. The alternative of determining energy consumption data on the basis of estimates, on the other hand, leads to higher costs.

**What has been the result of the amendment to the TSI LOC&PAS technical specification in the first quarter of 2020?**

**IB:** The amendment states that energy measurement systems on locomotives and multiple units must comply with the European standard EN 50463. This change became necessary because the previous remote data transmission

method by means of CSD transmission systems was outdated and has been replaced by modern LTE transmission systems.

**Why should vehicle keepers replace their non-compliant EMS?**

**IB:** The new transfer protocol requires a compatible EMS. Old systems no longer work and the use of estimated values leads to higher costs and no remuneration for energy fed back to the grid. Replacing the EMS is therefore recommended.

**What role does DB Systemtechnik play in this process?**

**PK:** We support vehicle keepers in procuring and integrating compatible EMS equipment. We offer tailored advice and technical support to make the process run smoothly.

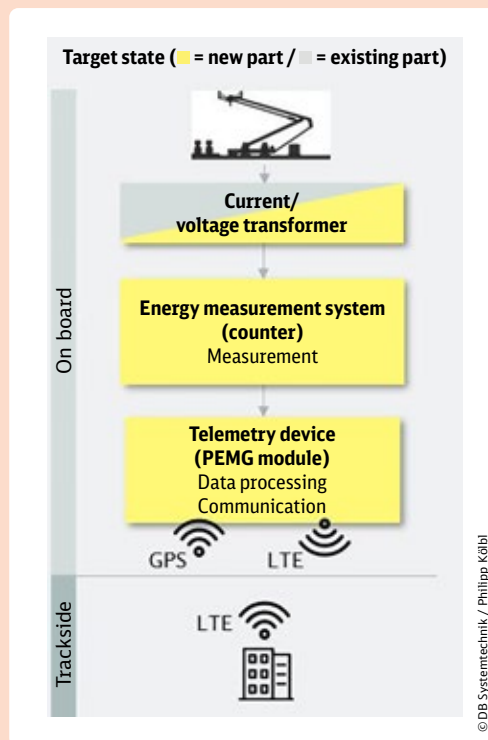
**Can you briefly explain what form this support takes?**

**PK:** Our services include taking an inventory of the vehicles, integrating the new EMS components, procurement support, preparing the necessary documents for procure-





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ment, approval compliant with TSI LOC&PAS and NNTR, as well as implementation support for production planning and retrofitting.

### Do you already have successful use cases?

**IB:** Yes, we have already supported DB vehicle keepers during upgrading. Our approach of tackling the entire EMS upgrade in a standardised way can be applied to every electric locomotive and multiple unit.

### What are the advantages for customers who opt for support from DB Systemtechnik?

**PK:** Our expertise ensures a smooth process, from planning right through to implementation. Customers benefit from efficient procurement and integration processes as well as reliable compliance with standards. We are ready to support vehicle keepers in efficiently replacing their energy measuring systems.



#### Philipp Kölbl (PK)

Philipp Kölbl comes from a dyed-in-the-wool railway family. It is therefore not surprising that he has also spent his career to date at Deutsche Bahn. However, his skills as a project manager not only benefit DB but also the German Alpine Club, in which he is active as a volunteer – when he is not on tour with his rock band.



#### Iven Billing (IB)

Iven Billing not only helps companies to be energy efficient – in his free time, he prefers to use his racing bike (in addition to travelling by train, of course...)



## Interior lighting measurements on the Taunus IdeasTrain for better safety and comfort

On the Taunus line network, ten type 786 carriages were converted into a unique IdeasTrain. The innovative IdeaSpace offers travellers a new kind of comfort and invites them to linger, exchange ideas and work. The conversion to modern LED technology with ambient lighting is intended not only to create a pleasant atmosphere but also to save energy. DB Systemtechnik was commissioned to measure the lighting in the IdeaSpace and ensure that the minimum illuminance levels for general and emergency lighting are met in accordance with TSI LOC&PAS and TSI PRM.

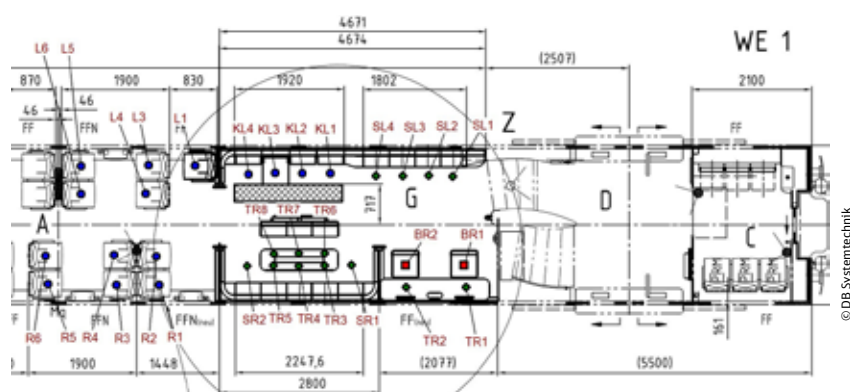
To evaluate the illumination of the IdeaSpace, precise lighting measurements were carried out in accordance with DIN EN 13272. The focus was on measuring illuminance for general and emergency lighting. Our experts took measurements at various locations on the train – at seats, in standing areas, at tables and in the aisle. In addition, directly adjacent steps and seating areas were also taken into account in order to obtain a comprehensive picture of the lighting situation.

On the one hand, the results of our lighting measurements are important for providing the necessary proof for the customer and, on the other, for ensuring maximum comfort and safety for passengers. The measurements



ensured that the minimum illuminance levels for general and emergency lighting were met in accordance with the TSI guidelines. This ensures that passengers always have sufficient light available – both for a relaxed journey and in an emergency.

Ambient lighting creates a pleasant atmosphere in the IdeaSpace and at the same time helps to save energy. Modern LED technology facilitates efficient lighting that supports passenger comfort while also being sustainable. Our services thus help to ensure that the Taunus IdeasTrain offers an illuminating experience for passengers.





# Forecast of operationally induced vibration – development of specifications and implementation of the validation within the European FINE-2 project

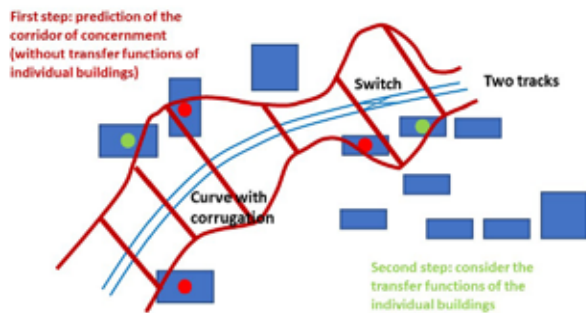


Fig.: Specifications on the procedure for preparing an operational forecast in a two-step process (the first step is the calculation of an affected zone and the second step is the assessment of the vibration in buildings within this corridor)

When planning new lines or upgrading existing lines, the operational vibration must be forecast and suitable vibration protection measures must be designed. In Germany, this is done as part of the planning approval process.

In contrast to airborne noise, however, no commercial programme yet exists for studying such vibration. Instead, the forecasts are usually made on the basis of tools developed by the individual assessors themselves. However, action was required because this can lead to considerable differences between the forecasts of different assessors and such programmes are extremely prone to errors and difficult to use. The European FINE-2 project, in partnership with the "SILVARSTAR" consortium, was launched to develop such a user-friendly programme with a graphical interface for modelling railway tracks. DB Systemtechnik was commissioned by DB Group's Europe's Rail programme to head "Ground Vibration" work package. In addition to coordination with the "SILVARSTAR"

consortium, which was commissioned to develop the methodological approach for forecasting vibration and to write the commercially usable programme, extensive work was also carried out in this work package on the development of specifications, model development and validation of the programme. One of the challenges was that, at the start of the project, there was no common basis accepted throughout Europe for the development of a forecasting programme. This meant that both the physical quantities to be used for evaluating the vibration and the procedure to be implemented first had to be agreed upon within the project team. Furthermore, extensive measurement campaigns were carried out to obtain measurement data that was used for validation of the tool. Launched in December 2019, the FINE-2 project will draw to a successful conclusion with a closing event in September 2023.

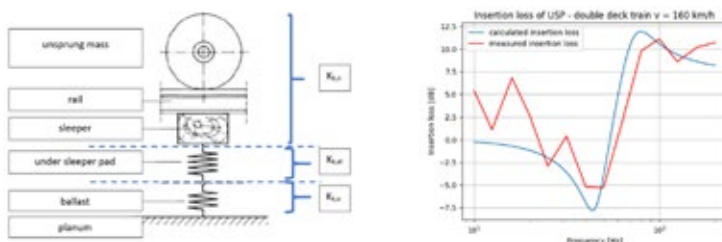
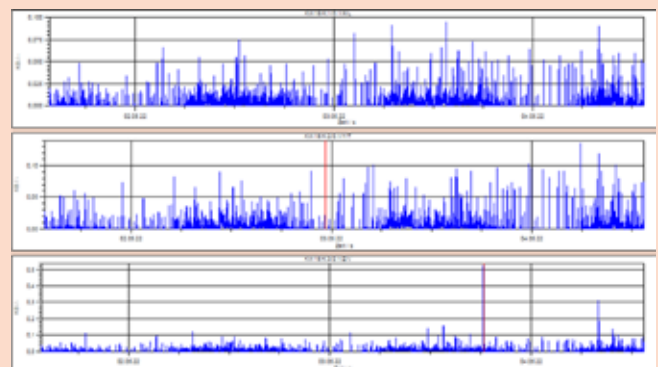


Fig.: Schematic representation of the model for calculating the effect of padded sleepers on operational vibration (left) and comparison of the calculated and measured effect (right)



Measurement location  
Airborne noise in the garden



© DB Systemtechnik / Katrin Tauscher

Maximum values in the time interval (KBFTi) of the weighted vibration strength (KBF(t)) at measuring points Mp x, y, z

# Effective monitoring of vibration and construction noise: installing permanent measuring stations in affected residential areas

## Three questions for our expert Katrin Tauscher.

We spoke to test engineer Katrin Tauscher from DB Systemtechnik to gain an insight into the company's approach to monitoring vibration and construction noise during construction projects.

**Ms Tauscher, could you please explain to us how DB Systemtechnik goes about monitoring vibration and construction noise in construction projects?**

**KT:** Of course, with pleasure. With construction projects such as the removal of a level crossing and the building of a road overpass, it is important to keep an eye on the impact on local residents. For this purpose, we have set up permanent measuring stations in accordance with the requirements of DIN 4150-2 and DIN 4150-3 as well as the general administrative regulations governing protection against construction noise (AVV Baulärm). These stations continuously monitor vibration and noise during construction work.

**How are the affected residents involved in this process?**

**KT:** The residents play an important role in this process. In accordance with the planning approval and the associated expert opinion, we inform the affected parties about the planned measurements and coordinate the installation of the measuring devices with them. In this way, we

ensure that they are informed about the monitoring measures and that their concerns are taken into account.

**How are the measurements carried out and what steps follow after they have been completed?**

**KT:** During construction projects, the measured values are monitored online. If the specified limit values are exceeded, the site manager immediately receives a warning message. After completion of the measurements, we prepare a comprehensive inspection report, which is then submitted to the competent authority. Thanks to these effective monitoring measures, we can check the immissions and minimise possible effects on the residents.



**Katrin Tauscher (KT)**

Katrin Tauscher and her team solve every problem concerning acoustics and vibration.



# Digital S-Bahn for Hamburg: on track for automated rail transport



The increasing demand for public regional and local passenger transport in metropolitan areas requires the digitalisation of S-Bahn (rapid transit) operations in order to create the necessary capacity.

The roll-out of Digital S-Bahn for Hamburg has brought us closer to this goal. The pilot project was part of the "Digital Rail for Germany" initiative, which encompasses the entire sector and enables digitalised rail operations for passenger services in Germany for the first time. The aim of the project was to closely integrate the infrastructure with the vehicle on the basis of the European Train Control System (ETCS) and Automatic Train Operation (ATO) technology.

Highly automated rail operation brings numerous advantages: service frequency can be significantly improved on the same line by installing equipment over a wide area, but without having to build a single new metre of track. Energy efficiency is improved as automated acceleration and braking reduce energy consumption. Overall, operations become more reliable and stable.

For the ITS World Congress 2021 in Hamburg, four Class 474.2 vehicles were retrofitted with ATO over ETCS / Automatic Train Operation according to GOA 2 (Grade of Automation). The resulting new Class 474.4 vehicles were temporarily approved for operation during the World Congress.

All that remained to achieve permanent approval of the vehicles was to complete the safety cases according to the National Notified Technical Rules (NNTR) for Germany. Particular focus was on item 05.2 (strength of the axle when subjected to torsional vibrations).

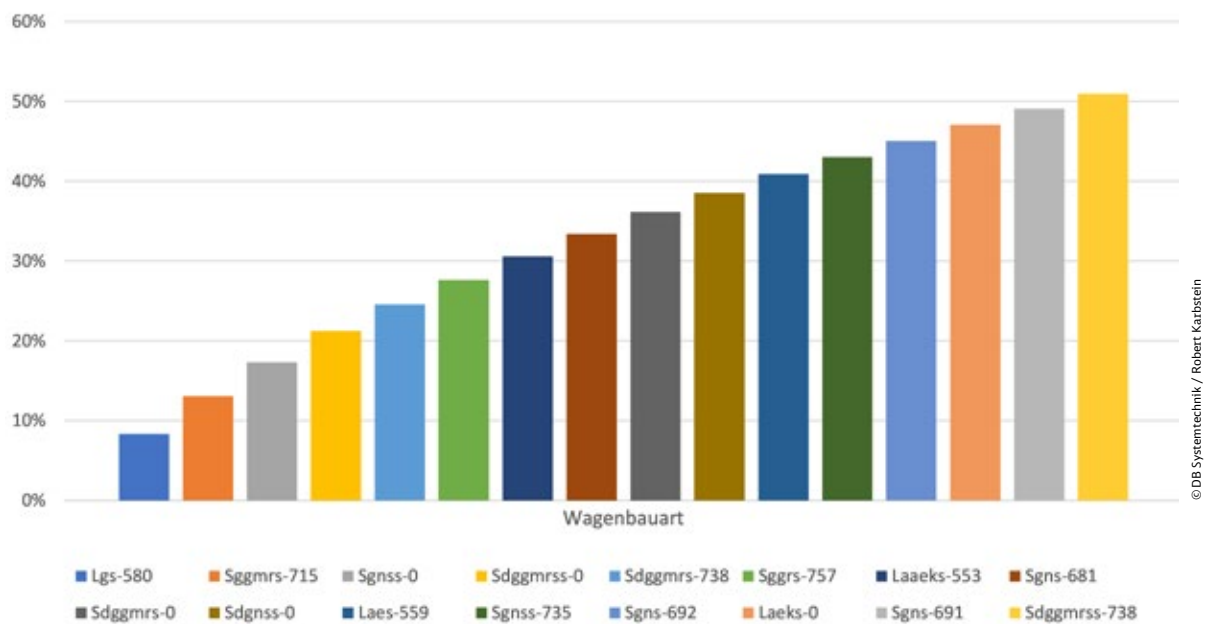
DB Systemtechnik proposed an alternative verification procedure to the authorising entity, based on the ERA guideline "Practical arrangements for the vehicle authorisation process". This replaced prescribed test runs with a computational procedure. The mathematical proof was based on experimental data from like-for-like measurement runs in the past. In this procedure, DB Systemtechnik was able to prove that, after retrofitting, the vehicles achieve at least the same safety level as vehicles that had not undergone retrofitting.

A detailed risk management procedure taking into account the mathematical proof served as the basis for the safety assessment report by DB Systemtechnik's Assessment Body (AsBo).

Railway Approvals Germany GmbH (RAG), in its capacity of designated body (DeBo), issued an intermediate statement of verification confirming compliance with the other NNTR items relating to the wheelsets.

The application for approval was submitted via ERA's "One-Stop-Shop" tool. The licensing authority was the Federal Railway Authority (Eisenbahn-Bundesamt) as Germany is the area of operation. The final notice of approval was issued within the regular processing period in July 2022. The first operational use in passenger service was on 29 August 2022.

The pilot project demonstrates how new technologies can make local transport in growing cities more efficient. The digitalisation of rail transport enables higher capacity, greater energy efficiency, more stable timetabling and improved passenger comfort. The partnership in this project has set new standards and is seen as a model for future projects.



The figure shows the frequency distribution of the wagon types. Wagon type Lgs-580 occurs in 8% of the total kilometric performance of all freight trains. The types of wagons shown account for more than 52 % of the kilometric performance. This information is needed for the virtual formation of trains in order to represent the virtual counterpart as realistically as possible.

## Unified Braking Scheme (UBS): innovative solution for increasing transport capacity in rail freight transport

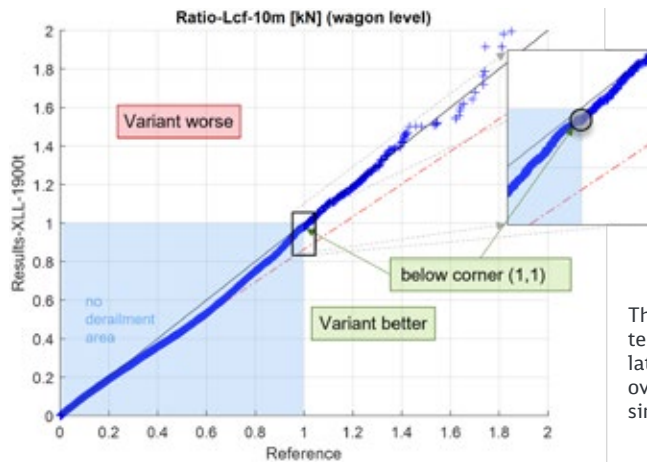
Increasing transport capacity in rail freight is a continuous endeavour of freight wagon operators. One of the objectives is to be able to include articulated wagons and semi-permanently coupled units in trains deployed in intermodal transport and braked with brake position P with a gross load hauled in excess of 1,600 tonnes. Currently this is not possible due to increased risk of derailment. The Unified Braking Scheme (UBS) project, promoted by the International Union of Railways (UIC) and Xrail, an association of well-known freight wagon operators, aims to remove interoperability barriers by providing operators with unified train formation rules.

The "Lange Lok" (LL) brake position, which has a much gentler effect, is to be expanded in the process. Instead of five wagons, it will be possible to place as many as seven

wagons (XLL) behind the traction units in brake position G in future. Brake position G enables a slow build-up of braking force within 18 to 30 seconds and thus controls all wagons, including those near the end of the train, relatively simultaneously. This extended braking regime is therefore of great importance, especially for longer trains.

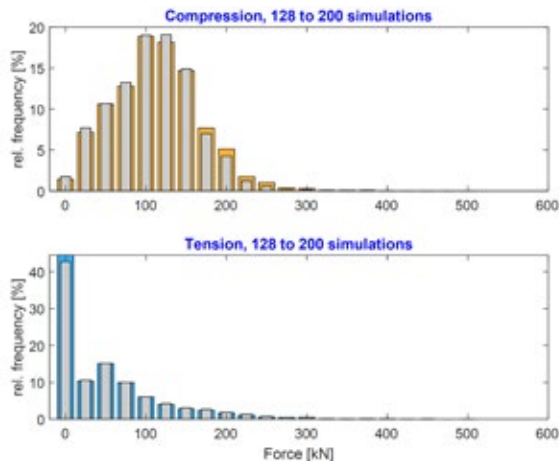
Since train formation is a stochastic phenomenon due to the variety of wagon types, wagon loads and order of the wagons, a corresponding stochastic analysis is required before reliable statements can be made.

DB Systemtechnik was therefore commissioned to use stochastic simulation methods to determine a mass limit up to which the use of articulated wagons and semi-per-



© DB Systemtechnik / Robert Karbstein

The upper diagram shows the compressive force, the lower one the tensile force: it is clear from the graph that the number of simulations is sufficient to be able to identify a meaningful trend. The overall distribution does not change any more as a result of further simulations.



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The figure shows a quartile plot for the ratio of force encountered to tolerable force on the wagons, thus identifying the potential for derailment.

If the ratio is  $<1$ , the probability of a derailment is very low.

The derailment potential begins at the marked point. The white area below the marked point shows that the risk for the variant (extra-long locomotive) is lower here than the reference case (current locomotives).

manently coupled units in P-braked trains would be possible by means of a modified brake position (XLL).

One of the core competencies of DB Systemtechnik's experts is the development of customised simulation environments. For the calculation of the longitudinal forces at the coupling points, the UIC simulation tool "TrainDy" was integrated into the stochastic simulation environment. This calculates longitudinal forces along trains.

In addition, with the help of simulation tools developed in-house in Python, train formation data from DB Cargo was filtered for intermodal trains and the frequency, for example, of gross loads hauled, wagon types and their load was determined. This made it possible to automatically generate several thousand different train formations

according to the principles of IRS 40421 and to analyse and evaluate them in terms of their longitudinal forces.

Based on comparative observations using the reference system of current operations, the positive effect of the "extended long locomotive" could be highlighted in a stochastic context, and the mass limit was increased by more than 18%. This ground-breaking development paves the way for more efficient and effective train formation in rail freight transport, which in turn contributes to increased capacity and more sustainable freight transport.



## DB Systemtechnik completes its first **major contract** in the **Balkan region**



DB Systemtechnik supported the Serbian state railway in commissioning the Belgrade–Budapest new-build line. We find out more in a conversation with Xing Liu (sales representative for the Asia region), Yilmaz Tosun (sales representative for the Region Southeastern Europe) and project manager Benjamin Reffay.

The Belt and Road Initiative (BRI) is a comprehensive infrastructure and economic development project that aims to promote trade and investment links between Asia, Europe and Africa. This order is part of this initiative.

### ***Could you give us some more background?***

**XL:** In this case, the project aimed to help improve the rail link between Belgrade and Budapest. Serbian Railways' infrastructure manager is in charge of retrofitting, modernising and constructing the double-track railway line from Belgrade to the border with Hungary, covering a track length of about 184 km.

**BR:** It was an upgrade and new-build project concerning a line that will be part of the Belgrade–Budapest link. With a maximum speed of 200 km/h for the first time in Serbia! This high-speed line is the first to be constructed in the Balkan region and is therefore of great importance for the country of Serbia and its government.

### ***Can you please give us a detailed overview of the origin and scope of this project?***

**BR:** This project also marks a turning point for us, as we have been awarded our first major contract in the Balkan region. Our main task was to support Serbian Railways in the commissioning of the new-build Belgrade–Budapest line. Our activities cover a wide range of tests, including vehicle dynamics, European Train Control System (ETCS), dynamic overhead line tests, GSM-R radio tests, contact wire rest position measurements, quasi-static track measurements using ground penetrating radar and geodetic surveying, and electromagnetic compatibility measurements.

Quite a wide-ranging project, considering that it was the first major order in the Balkan region for DB Systemtechnik.

### ***Can you tell us more about the strategic importance of this project for DB Systemtechnik?***

**YT:** Of course. The order consolidates our presence in the Balkan region and demonstrates our expertise in high-speed lines extending across national borders. The opportunity to participate in a project of this magnitude also opens up future prospects and underpins our business development in the region. At the same time, such projects help to promote Strong Rail throughout Europe.

### ***Such a large project requires a lot of planning – how did the project progress in detail?***

**BR:** We accepted two sections in early 2022: Belgrade–Stara Pazova and Stara Pazova–Novi Sad. In the process, we accepted the track itself as well as the overhead line and the train protection system (ETCS). We also measured the electromagnetic compatibility at substations, while the surroundings were measured using geodetic surveying and the subsoil using ground penetrating radar. We were only able to carry out these measurements by using our own track geometry cars with on-board measuring equipment. In such a large project, communication is also a key factor. We therefore introduced careful and precise reporting: every day, briefing meetings were held early in the morning and debriefing meetings on the current status late in the evening.

### ***Apart from these sessions, how did you interact with the customers and what was your communication strategy?***

**YT:** As Benjamin has already mentioned, our interaction with the customer was crucial to the success of this project. We worked closely with the decision-makers and the end customer to understand their needs and meet their requirements. Close collaboration and clear communication were essential to ensure successful implementation.



The Belgrade–Stara Pazova line section was built by the Chinese consortium CRIC-CCCC making China Railway an equally important contact in this project.

***What can you say about the collaboration in the project?***

**XL:** Working with international clients such as CRIC-CCCC and CRRC has been extremely rewarding, but also challenging. The physical distance and global restrictions due to the pandemic made communication and coordination difficult. Nevertheless, both sides put a great deal into our collaboration to achieve the goals we had set and to overcome the challenges.

***Mrs. Liu, in conclusion, could you tell us how the project went in the end?***

**XL:** Despite some challenges, including the coronavirus situation, the project was a success. The Serbian infrastructure manager was able to commission the line on schedule. The customer was therefore very satisfied and now appreciates what acceptance of a high-speed line entails.

***And there was also a grand finale?***

**BR:** Absolutely. It was particularly exciting that the Serbian President and the Minister of Transport were there in person when we rode at 180 km/h in our test train for the first time in their country during the ramp-up runs.

***Thank you for giving us such detailed insights into this project. We wish you continued success in the future.***



**Benjamin Reffay (BR)**

Project manager Benjamin Reffay had already been able to successfully apply his own expertise and that of DB Systemtechnik to the acceptance of the first high-speed line in Denmark. Following this, he moved on to Serbia. He looks forward to the next international challenge with great anticipation and is excited to see where he ends up next.



**Yilmaz Tosun (YT)**

Business development is one of Yilmaz Tosun's main tasks in his sales region, and he pursues with a great motivation and passion. His goal is to exploit the extensive specialist knowledge of DB Systemtechnik experts to enable customers to achieve long-term success.



**Xing Liu (XL)**

Global projects have to be designed globally – Xing Liu appreciates the efficient collaboration with colleagues over a distance of more than 8,000 kilometres.



## Riding the **king of the test trains** on the **Wendlingen–Ulm** new-build line



### Three questions for project manager Markus Basler.

The Wendlingen–Ulm new-build line entered service with the timetable change on 11 December 2022. The route is primarily intended to shorten the journey time between Stuttgart and Ulm. Prior to starting service, extensive test runs were made with the DB Systemtechnik ICE-S high-speed train to make a final check of the track. Project manager Markus Basler gives us more information about the test run.

#### **What makes the ICE-S so special as a test train?**

**MB:** The ICE-S, our "king of the test trains", can reach speeds of up to 400 kilometres per hour. This makes it ideal for test runs on high-speed lines. We started with slow test runs on the Wendlingen–Ulm new-build line and gradually increased the speed of the runs. In combination with the installed measuring instruments, our ICE-S was the perfect choice. For about three weeks during the spring, the ICE-S extensively tested the new line. Further runs, especially on the section of the route over the Filztal bridge in the direction of Wendlingen, were conducted before completion in autumn.

#### **How exactly does such a ramp-up run work?**

**MB:** You start slowly and drive at 40 km/h on sight to check that the track is clear and all obstacles have been cleared out of the way. After that, the speed is increased in stages. In this case, the final speed was 275 km/h. Such high-speed tests make it possible to test the interaction between train and track under real conditions. In particular, the interaction of vehicle and overhead line or vehicle and superstructure was tested in detail.

#### **Are any other measuring instruments used?**

**MB:** Our measuring equipment is the ICE-S itself. Additional measuring equipment was installed on the panto-

graphs and in the running gear. This is connected to the computers on the ICE-S, thus enabling immediate evaluations. This allows detailed information to be collected about the behaviour of the train and the track. But special measuring instruments were also installed at the tunnel portals. This was used to measure the pressure wave created by the train entering the tunnel, sometimes referred to as a "sonic boom".



**Markus Basler (MB)**

That kind of ramp-up run sounds exciting. Markus Basler thought the same thing: when he was a test manager, he was the one on the train taking the measurements. Nowadays, he is a project manager but is still on the train so that he can be close to the action.

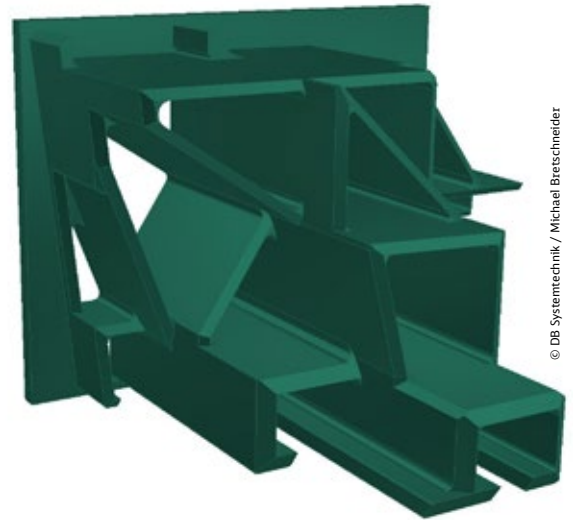


# Visualising complex solebar repairs using printed 3D models

DB Systemtechnik's centre of expertise for high-speed rail and electric multiple units runs a successful collaboration with DB Fahrzeuginstandhaltung (DB FZI) at the joint centre for accident remediation work at its site in Krefeld.

Accident repair is an area in which the two companies have been working together very successfully for a long time. They form a well-coordinated accident repair team, especially when it comes to complex accident remediation work on damaged vehicles in the long-distance fleet.

One current example of successful collaboration concerns the repair of a defective solebar. The solebar, a load-bearing structural element, was repaired by welding over a length of about 6 metres. The challenge was to repair complex, integral vehicle body structures and to restore the structural load carrying capacity. The welded joints in aluminium sections, especially in the case of butt welds, require extreme precision and careful repair of interfaces on the vehicle body. This repair was done by hand by the specialists at DB Fahrzeuginstandhaltung. For the first



3D design for model for solebar repair

time ever, a printed 3D model of the complex solebar interface was created at a scale of 1:5 to optimise this process. The model supplemented the usual detailed set of technical drawings from DB Systemtechnik.

## **This had the following benefits for the manual repair:**

- Improved comprehensibility of the drawings and a significantly simplified repair process thanks to the visualised design specification in the form of a model.
- Increased quality targets by reducing potential errors in the interpretation of drawings.
- Shortening of the repair phase on the vehicle body thanks to visualisation.
- The expertise of the two companies and the specialist knowledge of the teams involved help to ensure that damaged vehicles could be returned to service as quickly as possible.



3D-printed model of the solebar repair on a scale of 1:5



Solebar repaired on the basis of the 3D model

# Colourful future – innovative paintwork concepts in vehicle maintenance

## A conversation with Jens Otto, expert on surface and joining technology.

Vehicle painting is an important factor in vehicle maintenance, but until now it has been a time-consuming and energy-intensive process. The coats of paint to be applied normally require two painting procedures and subsequent oven drying, resulting in long turnaround times. In order to meet these challenges, DB Systemtechnik joined forces with DB Fahrzeuginstandhaltung (DB FZI) to launch a project called "Future Concepts for Painting in Vehicle Maintenance" as part of the Technology Projects Steering Group. Our interview with Jens Otto provides an insight into the research and development involved in these pioneering painting concepts.

### What exactly is the "Future Concepts for Painting in Vehicle Maintenance" project?

**JO:** Repainting car bodies in vehicle maintenance is a time-consuming and energy-intensive process. The required layers of paint (primer, colouring basecoat and clearcoat) are normally applied in two coats each, followed by oven drying at 60 °C for two hours. Additional work (such as masking for the different colour shades) can only take place once the vehicle has cooled down, which can take between 60 and 120 minutes, depending on the vehicle type. The project therefore aims to optimise the painting processes in vehicle maintenance in order to reduce both turnaround times and energy consumption. In short, we want to use innovative paint systems to make the repainting of vehicle bodies more efficient.

### What tasks is DB Systemtechnik taking on in this project?

**JO:** Our main task is to analyse the market for new paint products. Together with DB FZI, we select suitable systems for coating trials – first on sample panels and then

on complete vehicles. We organise, accompany and evaluate these trials in order to create a decision-making basis for the possible introduction of the new paint systems in various DB Fahrzeuginstandhaltung depots.

### What is the current state of progress in the project?

**JO:** Trial coatings on double-decker coach bodies with four paint manufacturers have been successfully completed. Another paint manufacturer is also scheduled for a trial. All products tested so far show an improvement over the current process.

### That sounds promising! What are the advantages of using the new paint materials?

**JO:** The new paint materials allow us to significantly reduce drying times, as oven drying is no longer necessary. This saves time and energy and thus optimises the painting processes in vehicle maintenance.

### What are the next steps you have planned?

**JO:** Next, the double-decker vehicles selected for the trial coating will be subjected to a targeted visual interim assessment after about a year. The condition of the paintwork as well as the glossiness and colour stability will be checked. Together with DB FZI, we will evaluate the results and create a decision-making basis for the use of the new products at various maintenance locations. At the same time, the paint manufacturers are working on acquiring approval for the new products in accordance with the requirements of DBS 918 300 in order to ensure regular delivery capability to DB.



Fast-drying basecoats require no additional oven drying

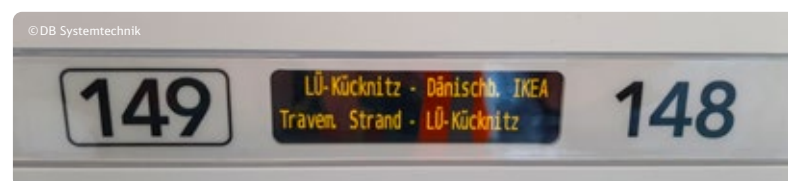


Use of a colouring primer, rendering a clearcoat unnecessary



### Jens Otto (JO)

In addition to his activities in connection with the introduction of innovative painting concepts at DB FZI, Jens Otto also supports the Surface and Joining Technology team in vehicle procurement projects, corrosion damage analyses and participation in standardisation committees.



## Successful introduction of electronic seat reservation for DB Regio Electric Network East (ENO), Schleswig-Holstein

There was little or no experience within DB for electronic seat reservation at DB Regio and there was no overall concept for the implementation of seat reservation for multiple units. In another DB project in the same region, seat reservation could only be partially implemented, emphasising the importance of correct implementation in the KISS-ENO project. The KISS-ENO project was undertaken in close collaboration between DB Regio and Nah. SH, the passenger transport authority for the Electric Network East (ENO) in Schleswig-Holstein. One of the biggest challenges was that, at the beginning of the project, the process for requesting and transmitting carriage identification numbers and reservation information was not defined and corresponding communication protocols first had to be agreed and developed.

Successful implementation required the creation of an overall concept by DB Systemtechnik. The relevant vehicle architecture, interfaces and signals were taken into account. Particular attention was paid to the input of the train number and the consideration of different seat layouts in the individual vehicle sections – even with

complex scenarios such as multiple traction, joining and splitting of trains and through services.

To ensure the reliability and functionality of the system, extensive tests were carried out in the laboratory, in stationary and moving vehicles, as well as during acceptance runs in the target network. In addition, DB Systemtechnik supported the end-to-end process from booking the reservation to displaying the reservation and vehicle identification number on or in the vehicle.

The successful go-live of the first fully comprehensive seat reservation system at DB Regio took place on 1 April 2023. This milestone established a blueprint on which further seat reservation projects at DB Regio can build. The KISS-ENO project now provides passengers with convenient and reliable electronic seat reservation in the Schleswig-Holstein region.





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## Wheelset diagnostics system on the Rhaetian Railway

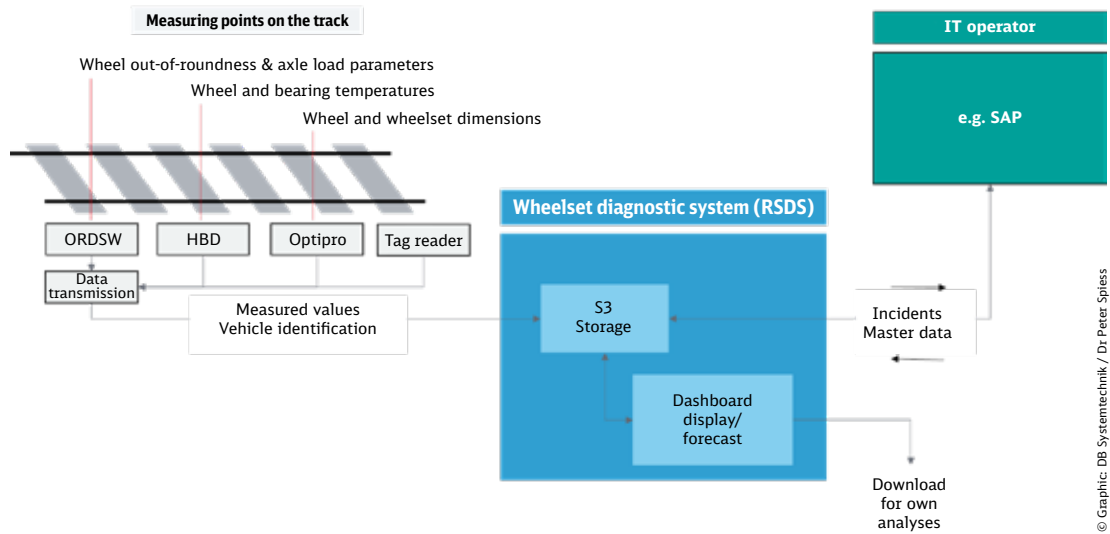
The Rhaetian Railway (RHB) operates its own narrow-gauge network in Switzerland. In order to optimise wheelset maintenance, the customer wanted a system that could continuously monitor the most important wheelset dimensions and parameters of their vehicles. In addition, the system is to be used to make forecasts about the time of the next wheelset overhaul and the estimated date for replacement of wheelsets.

In the project, DB Systemtechnik supplied RHB with two trackside checkpoints consisting of measuring systems and tag readers, as well as a wheelset diagnostic system

(WSDS), an IT system for processing and displaying the measured values recorded by the checkpoints. Each checkpoint consists of an Optipro measuring system for wheelset dimensions, a Dafur system for determining wheel loads and out-of-roundness, a hot axle box locator and a tag reader for vehicle and wheelset identification. The data collected by the measuring systems is compiled on the Dafur system each time a train passes and is forwarded to the WSDS.

In the WSDS, the data on passing trains is stored in a database and can be displayed there. The WSDS receives





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master data from RHB as well as measurement data from the maintenance team, enabling uninterrupted tracking of the development of wheelset dimensions. A forecast function tells the user in which period of time a wheelset is likely to require an overhaul. A comparison of the measured values with limit values also makes it possible to send warnings.

One particular challenge during the project was the integration of measuring instruments and IT from several different manufacturers into a holistic system that functions according to the customer's wishes.

With the solutions it developed, DB Systemtechnik supported the customer in optimising wheelset maintenance and thus contributed significantly to the customer's increased efficiency and forecasting capability.

# Telemetry solution for vehicle monitoring:

## DB Systemtechnik equips NX Rail fleet



NX Rail in Cologne is part of the British National Express Group and, with around 21 million train kilometres per year in the greater North Rhine-Westphalia area, is the largest private rail company in the region. To monitor its fleet in operation, NX Rail was looking for a suitable system for transferring vehicle data.

DB Systemtechnik was therefore asked by NX Rail whether it could provide a solution for the transfer of diagnostic and process data of the company's Class 442 trains.

After a successful workshop at NX Rail in Cologne, where DB Systemtechnik's iRAT and FALKOS telemetry technologies were presented, the experts were commissioned to equip a vehicle with a sample solution. DB Systemtechnik's engineering team in Krefeld was commissioned by NX to carry out the installation tests.

On 30 November 2021, the first vehicle in the Düsseldorf depot was equipped with components from our development partner optiMEAS. After switching on the ECM2, Mr Berner was able to see live data from the MVB vehicle bus on his laptop, which was transmitted to a cloud instance

of the Falkos platform. The dashboard in the Falkos IoT platform was already pre-configured by the DB Systemtechnik team and featured NX Rail's corporate design colours.

A BatMon (battery monitor) from optiMEAS was also installed, which even monitors the battery state of charge when the train is shut down and can wake up the iRAT telemetry box and send a warning message to the trackside if necessary – a request from NX Rail, as the battery is one of the frequent sources of faults in operation.

Thanks to the successful proof of concept, DB Systemtechnik was awarded the contract to equip the fleet of 35 vehicles with DB Systemtechnik's telemetry solution by the end of 2023.

The National Express team and DB Systemtechnik are enthusiastically working in partnership on the implementation and further ideas that will enable data-driven decisions to be made during operation and regarding maintenance of the vehicle fleet.





# Production and commissioning of instrumented wheelsets for Alstom project in Sweden

**In an interview with Philipp Meyer (expert for vehicle/track interaction tests – instrumented wheel sets and measuring equipment), we find out more about the order.**

**Can you explain the background to the order for us?**

**PM:** Of course. In 2021, our vehicle/track interaction specialist testing department received a significant order from Alstom's rail vehicle testing centre in Hennigsdorf. The order comprised the production, calibration and commissioning of four instrumented wheelsets for running tests on a new regional multiple unit in Sweden. This multiple unit, which is designed for a maximum speed of 200 km/h, was ordered by Västtrafik, Sweden's second largest transport association.

**That sounds like an exciting project. Were there any special requirements for the instrumented wheelsets?**

**PM:** The instrumented wheelsets are equipped with wheel-mounted brake discs and provide not only the horizontal and vertical wheel-rail contact forces but, at the customer's request, also the longitudinal forces at the wheel-rail contact point. With the wheelsets installed, these were calibrated for the first time on site by means of customised adaptations to our calibration technology. This also means that we can now make this option available to our customer on a flexible basis. This helps to make the inspections and analyses even more accurate and meaningful.

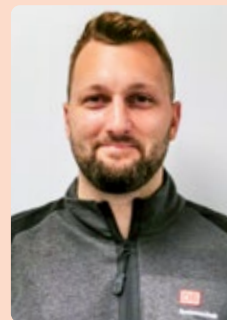
**That sounds like a significant improvement for the customer. How was this project carried out?**

**PM:** The tests extended over several months, especially in the winter months with temperatures below -10°C. However, thanks to the inductive transmission of the energy and the measurement signals, these temperatures presented no problems. Our activities were largely limited to the production, calibration and commissioning of

the instrumented wheelsets, as well providing technical support to the Alstom Hennigsdorf testing centre at the beginning of the measurement campaign. Even after this, thanks to remote access, we were able to analyse the system at any time and offer support if needed.

**That sounds like a very efficient job. Were you able to bring the project to a successful conclusion?**

**PM:** Yes, absolutely. After the four instrumented wheelsets had been installed on the train at Hennigsdorf in 2022 and the measuring system had entered service, we were able to calibrate the wheelsets, including horizontal and vertical wheel-rail forces. The train was then transferred to Sweden, where the Alstom Hennigsdorf testing centre had planned measurement runs on various lines. We then calibrated the longitudinal forces of the instrumented wheelsets while running, which was a new experience for us. The instrumented wheelsets operate reliably, even at extreme temperatures, and help to analyse the train's running characteristics with high degree of precision. Once the Alstom Hennigsdorf testing centre had notified us of completion, we dismantled the entire measuring equipment of the instrumented wheelset system.



**Philipp Meyer (PM)**

When Philipp Meyer is not on test runs in freezing conditions, he designs and manufactures telemetry attachments, sometimes with the aid of a 3D printer.



## Extensive engineering on advanced TrainLab (aTL) by our engineering experts

**A conversation with Patrick Raabe (head of Vehicle Design), Jörg Jacob (head of Special Vehicle Design) and Florian Hoyer (electronics engineer).**

**Mr Raabe, in what precise area is your team's expertise?**

**PR:** Our team is responsible for mechanical and electrical engineering in vehicle retrofit projects for passenger transport and special vehicles. For example, all major redesigns of the long-distance fleet (ICE 1-LDV, ICE 3, currently the ICE-T customer programme) have been implemented by our experts. In addition, we facilitate special design solutions on rail vehicles, such as the installation of modern sensor technology for Automatic Train Operation (ATO) for the advanced Trainlab (aTL). We offer the complete package – from specification of the customer's requirements and comprehensive engineering through to support for the vehicle retrofit in the depots.

**Mr Jacob, what is special about engineering for the advanced TrainLab?**

**JJ:** The special feature is the complexity of the retrofits. It all started in 2019, when we were working with Digital Rail for Germany to develop and install a sensor platform for ATO. A state-of-the-art fire extinguishing system was also installed and innovative evaluation electronics were integrated into fireproof control cabinets. We also integrated a measurement system for the development of a driver assistance system.

**What happened next?**

**JJ:** After that we dealt with design aspects of the installation of an antenna support on the aTL. Various types of antenna for mobile communications and train radio are being tested on this support, which will be integrated into future rail vehicles. The focus here is on testing innovative antenna systems for the new, high-performance, 5G-based standard for the Future Railway Mobile Communication System (FRMCS), which is replacing GSM-R. Our latest project is the KI-MeZIS research project ("AI methods in condition monitoring and needs-based maintenance of rail vehicle structures"). The aim is to tap the potential of artificial intelligence (AI) methods for monitoring train movements.

**Mr Hoyer, tell us something about the automatic impact detection system on the aTL.**

**FH:** As part of the project funded by the German Ministry for Economic Affairs and Climate Action (BMWK), we are working alongside the German Aerospace Centre (DLR), the Institute for Machine Elements (IMA), Industrial Analytics GmbH, Deutsche Bahn (DB) House of AI, the Institut für Bahntechnik (IFB), Maschinenbau und Service GmbH (MSG), and DB Netz on a system for detecting collisions and rollovers in rail transport. This work comes under the umbrella of the Digital Rail for Germany (DSD) sector initiative. Both the running gear and the front nose of the aTL are equipped with various sensors.



**Patrick Raabe (PR)**

Head of Vehicle Design



**Jörg Jacob (JJ)**

Head of Special Vehicle Design



**Florian Hoyer (FH)**

Electronics engineer



During subsequent on-line running test, the forces acting on the assemblies will be measured and recorded. Furthermore, data on actual impact events is generated in laboratory tests and by means of simulations. The data obtained is used to train AI algorithms. In future, these algorithms should evaluate the condition of the vehicle and, if necessary, issue corresponding instructions.

#### ***What is the next step for the team on the aTL?***

**PR:** Following the successful tests, we are now going one step further in the "KI-MeZIS" project. The sensor setup will grow in three phases to a total of 42 sensors. In addition, cameras and satellite-based localisation will be used in the future to annotate events during the journey. The measurement data that us collected no longer remains on the aTL itself but is processed by AI mechanisms and made available to the project participants in the cloud.

Another exciting project we are currently involved in is the "Connectivity Test Platform" project. In this project, the advanced TrainLab becomes a mobile communications measurement train, assisting in the testing of future mobile communications technologies for passengers. It involves equipping carriages with new internal and external instrument boxes to create a basis for assessing net-

work coverage as well as the performance of the mobile network operators. This will also enable the performance of laser-treated windows or active roof antennas to be tested under real conditions in the future. This is how we are making our contribution to Strong Rail and helping to fill in the "not-spots" on the mobile communications coverage map.

***We are very excited to see what other new technologies and projects await us on the advanced TrainLab.***

3D model of the advanced TrainLab – developed and designed by the experts at DB Systemtechnik



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# RIS 1.5 double-decker coach for the Electric Network North, Magdeburg

| RE20 Magdeburg Hbf |         |                       | 14 00       |
|--------------------|---------|-----------------------|-------------|
| Nächste Station    |         |                       | Ankunft     |
| Magdeburg-Neustadt |         |                       | 12:45 12:45 |
|                    |         |                       | Gleis 2     |
| Gepflegt           | Ankunft | Station               |             |
| 09:43              | 09:43   | Stendal Hbf           |             |
| 09:55              | 09:55   | Hohenwulsch           |             |
| 10:13              | 10:13   | Salzwedel             |             |
| 10:23              | 10:23   | Schneega              |             |
| 10:29              | 10:29   | Soltendieck           |             |
| 10:34              | 10:34   | Wieren                |             |
| 10:38              | 10:38   | Stederdorf(Kr Uelzen) |             |

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Class 2003 double-decker vehicles are equipped with a passenger information system (RIS) which provides passengers with up-to-date information on stops and alterations to train services. In the past, an RIS server for intelligent vehicles (IFZ) communicated with the back office (BO) vehicle via text messages so that actual data could reach the vehicle. Deactivation without replacing the RIS server, which is responsible for the text message communication, required a new way of sending up-to-date data to the vehicle.

DB Regio Südost was therefore looking for a solution for the current communication procedure that would be suitable as a substitute for the transmission of actual data to

the vehicles. The DB Systemtechnik Passenger Carriage Engineering Competence Centre was directly approached and commissioned as a partner for the installation engineering.

All vehicles in this double-decker series are equipped with GSP components for passenger information. Component communication is based on a proprietary development by GSP, which cannot be accessed.

Nahverkehrsservice Sachsen-Anhalt GmbH's request to implement communication as on the Class 425 thus presented a challenge. All 48 double-decker vehicles on the ENorM network were already equipped with WLAN, whereby DB Systemtechnik experts worked on design aspects of the installation. As a result of this WLAN system, there is a Colibri central computer on the vehicles, which is used as a container for the RIS vehicle 1.5. The problem of insufficient communication with GSP devices was counteracted by developing software for the Colibri central computer, installing a train-wide network and various individual components.

Furthermore, the passenger information monitors experienced repeated failures, resulting in frequent penalty payments. It was possible to replace these monitors with alternative, modular models during the subsequent work, resulting in lower costs and stabilised operation of the vehicle fleet.

The way in which the partners collaborated is also worthy of mention, as the project was implemented directly with Region Southeastern Germany. The team at the DB Systemtechnik Centre of Expertise for Carriage Engineering in Wittenberge was able to ensure the integration of the new RIS components, including the changeover to mobile working, even under "coronavirus conditions".



© DB AG / Wolfgang Wagner

## Environmentally friendly future: study on the conversion of Deutsche Bahn diesel vehicles to hydrogen propulsion

DB Systemtechnik has paired up with the scientific partners Karlsruhe Institute of Technology and WTZ to prepare a study on behalf of DB's TecLab on the subject of "Investigating the possibilities of converting Deutsche Bahn vehicles to hydrogen-powered engines to achieve climate-neutral operation".

The aim of the study was to take a closer look at individual vehicle classes that could be considered promising for conversion to hydrogen power. First, the required retrofitting measures were analysed and their feasibility estimated. It was very important to identify the tasks and particular difficulties that would require special attention in subsequent work. This study can therefore be seen as a preparation for actual retrofit projects.

Classes 245, 623, 633 and 741.1 were the vehicles examined.

In addition to gathering information on vehicles and alternative propulsion systems, DB Systemtechnik's



Existing GAF 100 diesel engine (MAN D0826)

activities also focussed on vehicle integration. This includes the topics of mass balance, rough analysis of structure gauge, installation space analysis and a tank integration concept.

It was possible to demonstrate that a conversion to hydrogen operation is possible for the vehicles included in the study.



## Smooth running on the railway – high-precision measurements during production

The manufacture and repair of wheelsets is a demanding process. In order to manufacture quality products, the individual components such as the wheels and wheel hubs are subject to tight geometrical tolerances. Stable and controlled manufacturing processes are essential for consistently high quality.

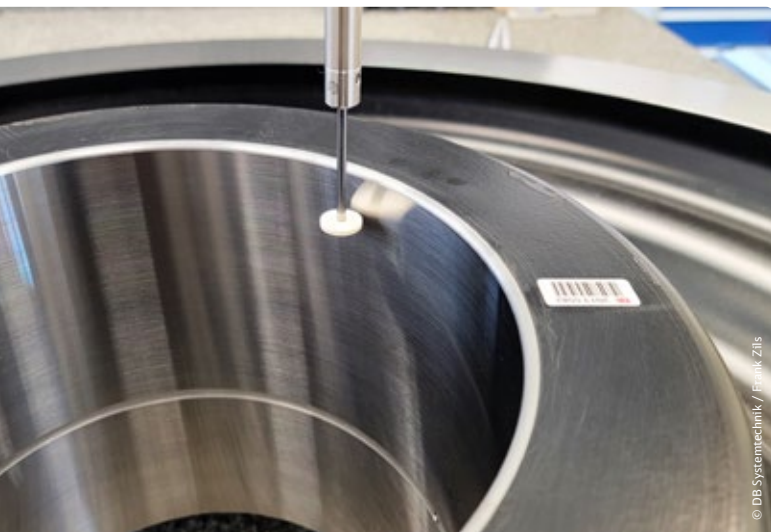


Photo showing an example of a wheel disc

DB Systemtechnik's services include calibrating the processing machines for these manufacturing processes to enable the required tolerances on the wheels and wheel hubs.

In some cases, variances are detected during calibration that call the continued operation of wheelset production into question. Specifically, compliance with geometric requirements for the wheel hub bore could not be proven with certainty.

Experts from the Laboratory for Quantity with Dimensions in Chemnitz analysed the situation together with colleagues specialising in measurement processes and came up with short-term solutions that enabled production to continue.

In addition to longer-term proposals for the fundamental stabilisation of the production-related measurement processes, a production-related measurement based on sampling was established as a short-term solution.

Within a few hours, a measuring process was developed and validated at the Centre of Expertise for Coordinate Measuring Systems in Chemnitz. This made it possible to measure wheel discs during series production so that a large number of wheels could be measured in the shortest possible time and made available for wheelset production.

On the basis of this measurement campaign during series production, it was possible to maintain wheelset production and improve it in terms of the manufacturing process. Further measures and the substantiated measurement data made it possible to reduce the sample size over time while maintaining the same level of reliability in production.

To ensure that everything continues to run smoothly in the future, the team in Chemnitz will regularly carries out measurements during series production, thereby helping to maintain vehicle availability.





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Interview

## Good reception, comfortable conditions – evaluation of frequency-transparent windows in trains

**A conversation with Antje Trautwein (expert for HVAC systems) and Christian Kümpfel (expert for condition-based maintenance systems, processes and technologies).**

***The increasing importance of mobile communication requires an efficient way to ensure continuous reception even on trains. What is the situation at DB?***

**CK:** As a traveller, I get annoyed myself when the mobile signal on the train is not sufficient to deal with my e-mails, for example. Deutsche Bahn is working on a solution to the problem of poor mobile phone reception on its trains. The "Subsequent Laser Treatment" project aims to make the windows of the existing fleet frequency-transparent by processing them on the train itself to avoid having to remove and reinstall them. In order to make the windows frequency-transparent, the wafer-thin metal layer within the laminated window is to be partially removed with a laser. The great advantage is that the frequency-transparent windows require little maintenance and cannot fail. So far, only a few new vehicles have been equipped with frequency-transparent windows, while most existing trains have a metal coating that impairs reception.

***What progress has already been made and what are the long-term goals of the project?***

**CK:** In an initial proof-of-concept, three parked used vehicles were successfully treated. In the next stage, reference trains will be receive laser treatment and be deployed in passenger service by DB Regio. Initial tests show a significant improvement in reception by a factor of 100 or more. Our goal is to use the laser process in the DB Fahrzeuginstandhaltung, DB Fernverkehr and DB Regio maintenance depots in the coming years. In doing so, we want to keep the amount of work to a minimum so as not to interfere with regular maintenance. We are striving for a comprehensive solution to sustainably improve mobile phone signal reception in all DB trains.

***What form does the collaboration in this project take? What services are being provided by DB Systemtechnik?***

**CK:** We were commissioned by DB AG for the technology subproject, in which we are contributing our expertise and experience in areas such as measurements, electromagnetic compatibility (EMC), approval procedures and functional statements of work. We ensure compliance with EMC requirements and other technical parameters by means of extensive measurements and analysis procedures. In addition, we are involved in defining the



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functional statement of work to ensure that the treated windows meet the required standards. In this way, we are making a significant contribution to the success of the project.

**Better reception without loss of comfort – that is the ideal world you are aiming for. Could the laser-treated windows have a negative effect on the temperature in the train?**

**AT:** The current metallised windows have good thermal properties, but as already explained, do not allow radio frequencies to pass through. Integrating frequency-transparent windows could actually influence their thermal properties and thus increase the thermal load of the passenger area. This might then be noticeable on the train, even if phone reception is better. Of course, DB Fernverkehr would like to avoid this situation. So the goal is better reception and comfortable temperatures.

**That means any such negative influence must be ruled out before we go any further. And that's where your expertise as an HVAC expert comes in! How did you go about the evaluation?**

**AT:** Detailed research on vehicle and geometry data was first conducted to assess the influence of the frequency-transparent windows on energy consumption and

thermal load. Data on wall and window construction, occupation and the HVAC system played an important role. The project team then created a simulation model which enabled the effect of the frequency-transparent windows on energy consumption and heat load to be calculated precisely. It was particularly important to pay close attention to thermal comfort in the interior so that everyone would experience a pleasant journey on the train. For those responsible, it was also important whether and to what extent the energy consumption of the HVAC system would increase.

**Question: What insights were you ultimately able to gain?**

**AT:** Our studies showed that no significant impairment of passenger comfort is to be expected. The frequency-transparent windows enable better reception without sacrificing passenger comfort. Energy consumption increases a little. We were able to evaluate and eliminate any restrictions or disadvantages in the use of the frequency-transparent windows. This ensures that our passengers benefit from modern processing technologies without sacrificing comfort.



**Christian Kümpfel (CK)**

Christian Kümpfel not only enjoys working on train innovations, but is also interested in aircraft. He flies regularly on his Airbus A320 flight simulator, enjoying continuous connectivity.



**Antje Trautwein (AT)**

Originally from northern Germany, Antje Trautwein has now been living in Bavaria for eight years. She likes to spend her free time outdoors with her family or travelling through Germany to visit friends and family. No matter where she is, her comfortable temperature is exactly 24 degrees.



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## Selected projects DB ESG





## Turnkey delivery of a selective door operation system for Transport for Wales

In 2021, DB ESG carried out a feasibility study on behalf of Transport for Wales Rail (TfWR) into the requirements and installation of a selective door operation (SDO) system to be used in the fourth generation (MK4) passenger carriages. Both manual and automatic SDO systems were considered. TfWR operates a fleet of locomotive-hauled MK4 passenger trains in intercity services, which previously had no selective door operation.

However, stations where the platform is shorter than the incoming train necessitate the use of such a system. Following the feasibility study, DB ESG was awarded a contract by TfWR in December 2021 to develop and install a manual SDO system for the TfWR fleet of eight carriage sets consisting of MK4 carriages and driving trailers. At

the time, DB ESG was already working on modifications to this fleet on behalf of TfWR and Eversholt Rail in order to be able to operate the MK4 carriages in push-pull mode with Class 67 locomotives and driving trailers.

Following a thorough examination of the risks and profitability, TfWR opted for a manual system, as this could be delivered within the trains' modification period. The manual SDO system was to be designed so that it can be used to manually override an automatic SDO system should one be retrofitted to the fleet in the future.

DB ESG was responsible for engineering services, design, approvals, material procurement and assembly in this SDO project. The project was completed in 2022.

# New design and additive manufacturing of sensor housings for Angel Trains

DB ESG's expertise in digital manufacturing, including 3D printing (also known as additive manufacturing or AM), offers not only the opportunity to re-manufacture out-of-stock components, but also the chance to fix component design flaws, with the added benefit of producing prototypes to test design changes.

In 2022, Angel Trains commissioned DB ESG to redesign and additively manufacture a housing for a climate sensor in the interior of vehicles. The sensor is used to measure temperature and humidity in the passenger areas. The original sensor housing had several design flaws: it had no locking mechanism to connect the two halves of the housing, no clamping device for the batteries and no fire resistance.

## **DB ESG redesigned the sensor housing to allow for the required modifications:**

- Snap connections in both halves of the housing so that the halves lock securely into each other and are easy to open for access to the sensor.
- Semi-circular battery holder to secure the battery in place.
- Option for the installation of PCBs fastened with self-tapping screws.
- Furthermore, the construction was also designed for production using fused deposition modelling (FDM) AM technology with Ultem™ 9085 black printing material to meet fire safety requirements.

## **In 2023 Angel Trains commissioned a design change with the following specifications:**

- Installation of three batteries (in place of the original one battery) and a longer circuit board (due to the integration of the climate sensor into a new PCB instead of the previous wired antenna connection).
- Two threaded inserts in the sensor housing that allow the use of Torx safety screws as secondary fixing.
- A PETG prototype of the new sensor housing was submitted to Angel Trains for approval and testing (see Figure).







## Tram safety in good hands: making every journey a safe one

In January 2019, DB ESG was selected by Transport for London following a bidding process to develop, design, install and commission a physical prevention of over-speeding (PPOS) system on London Trams' light rail vehicles in the Croydon area. To this end, DB ESG collaborated with Sella Controls, which supplied the hardware and software, including the PPOS control system and a Tracklink III system.

This system has been fully operational for over a year and has proven to be exceptionally efficient with 100 percent

availability and zero system failures. In February 2023, the independent safety assessor certified the hardware and software of the over-speeding protection system as safety integrity level 2 (SIL2).

This SIL2 certification is the first in the UK for an over-speeding protection system for light rail vehicles and provides an independent guarantee of safety.





## • **Additional highlights**



## Additional highlights



## Brandenburg's Minister President and DB board member visit **Kirchmöser rail centre** in Brandenburg an der Havel

On 3 April 2023, Minister President Dr Dietmar Woidke and Dr Daniela Gerd tom Markotten, Board Member for Digitalisation and Technology at Deutsche Bahn, visited the Kirchmöser rail centre in Brandenburg an der Havel, Germany.

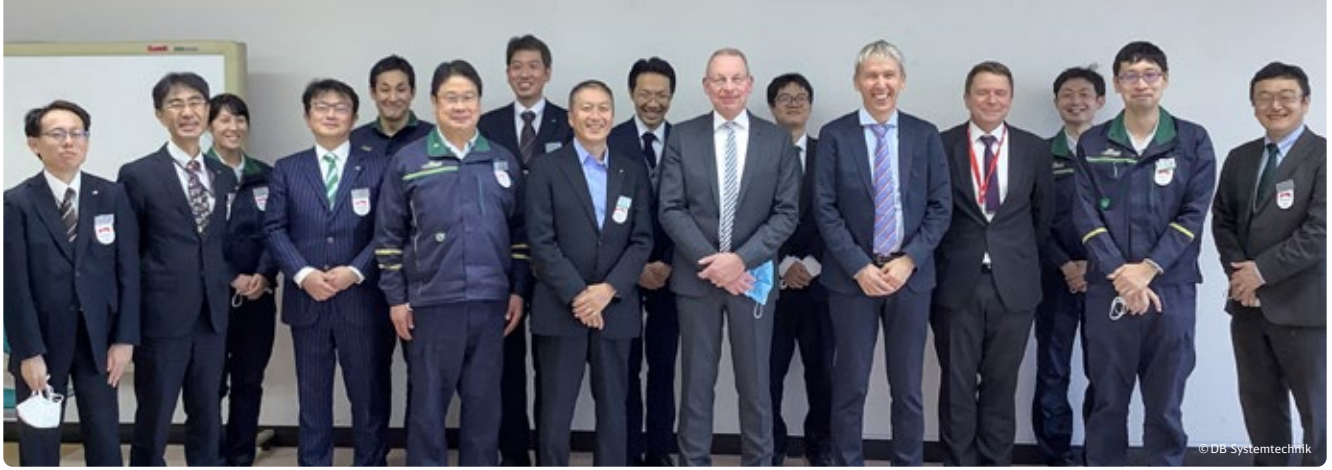
A maintenance depot was first began operating there in 1924, having been established by the former Deutsche Reichsbahn. Since then, Kirchmöser has developed into a renowned centre of expertise for railway technologies and is now also a high-tech facility for DB Systemtechnik.

Our Brandenburg-Kirchmöser site, with its Maintenance Technology business line, is one of three main locations of Europe's largest centre of expertise for railway technology. At this site, we have pooled our expertise and specialised engineering knowledge in the fields of maintenance systems, materials science and engineering, fire

protection, non-destructive testing, maintenance depot design and mechanical engineering for the maintenance of rail vehicles. An additional metrology and calibration technology facility is located in Chemnitz, Saxony.

During the visit, the guests were given fascinating insights into the tasks and services at the site. During the subsequent tour of the test facilities at the technical centre for diagnostics, the visitors were impressed by the laboratories for non-destructive testing and fire testing as well as by the wheel/rail test rigs.

Today, Kirchmöser is a place where staff work hard every day to come up with ground-breaking innovations. This is where all the tinkering, testing, developing and planning is done – with the aim of ensuring safe and reliable railway operations.



## Japan Partnership 2022: DB AG and JR East collaborate on advanced rail technologies

As part of the 30-year partnership between JR East (East Japan Railway Company) and DB AG, a one-week meeting between technical experts from both companies took place in Tokyo in November 2022. More than 40 experts and managers took the opportunity for a thorough exchange of ideas about relevant specialist topics and current developments in rolling stock engineering, infrastructure, control-command and signalling, digitalisation, safety and station development. Once again, experts from DB Systemtechnik were on hand to explore trailblazing areas of collaboration with JR East.

Traditionally, the location of this annual exchange alternates between Japan and Germany. The 2022 event once again comprised three days of detailed technical discussions and one day with participation from the boards of the two companies. This was followed by a technical visit to selected JR East plants. A special ceremony was held to mark the 30th anniversary of the partnership and 150 years of rail transport in Japan.

## DB Systemtechnik achieves **overall rating of 80%** in customer satisfaction survey

If our customers are happy then so are we! With a rating of 80% overall satisfaction, we are proud that we meet expectations. However, we are not resting on our laurels, but promise that we will continue to focus our work on the wishes and needs of our clients. Feedback is important to us, so we take all suggestions and comments

seriously as we implement targeted measures to increase satisfaction levels. Our goal is continuous improvement. Many thanks to all customers who took part in the survey. We look forward to further collaboration and interaction!







## Celebrations in Kirchmöser: 500th test axle for safe rail transport!

In September 2022, a special milestone was reached: the 500th test axle for the ultrasonic testing of axles was manufactured at our site in Kirchmöser.

In the rail sector, non-destructive testing (NDT) is indispensable for safe operation. Rail vehicle axles in particular must be subjected to regular ultrasonic testing in order to detect possible damage such as cracks or corrosion at an early stage and ensure timely replacement.

Regular quality checks are essential to ensure that the testing facilities always operate at a consistent level. Test axles containing specific reference defects for ultrasonic testing are used for this purpose.

DB Systemtechnik has been manufacturing test axles since 2001 and has built up impressive expertise in the process. Test axles are continuously being manufactured

for all required vehicle classes and depots, both for regular operational testing and for the manufacture of new axles with a longitudinal bore.

The quality of the test axles has impressed maintenance companies both nationally and internationally. However, the DB Systemtechnik team is not standing still, but looking towards the future. Their focus remains on the continued development of ultrasonic testing and optimisation of testing facilities in order to increase the availability of rail vehicles and ensure safe operation – for the benefit of both customers and passengers.



## Our expertise in **optimising maintenance of** metro trains in China is in high demand

The railway system in China is the largest in the world and includes a dense regional and local transport network with metro lines in numerous megacities. With the oldest metro lines being about 30 years old and now requiring a great deal of maintenance, the topic of "optimising maintenance" has now arrived in China.

With years of experience, DB Systemtechnik is introducing proven methods at just the right time. A preliminary study showed that about 25 % of maintenance work can be saved through consistent application of optimisation suggestions.

CRRC Tangshan contracted DB Systemtechnik to optimise maintenance of its Line 1 in Tianjin, a city of 9 million near Beijing, with the aim of lengthening the intervals for heavy maintenance from 5 to 7 years. Studies are already in progress regarding a further optimisation project for operational maintenance for the Fuzhou metro.

The assessment is being conducted in accordance with European and German standards, calling for close collaboration between the client's experts and those at DB

Systemtechnik. Face-to-face meetings between the teams are essential to move the project forward successfully. Colleagues from DB ESG are also involved in both projects and are contributing their expertise in condition-based maintenance and technical advice.

DB Systemtechnik is accompanying the maintenance plan amendment process in accordance with the specifications of DIN EN 17023 to ensure optimum and legally compliant implementation. The project aimed at extending maintenance intervals is expected to be completed by the end of 2024, while the optimisation of operational maintenance for the Tianjin 1 metro line also continues to make progress.

The projects are linked to several training activities to guarantee sustainable expertise when implementing the optimisation measures in China. These are the first such pilot projects in China, and we anticipate further follow-on projects of the same kind.



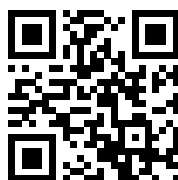


## DB Systemtechnik heads off to **southeastern Europe** for further endurance tests with the DAC4EU demonstrator

During the summer of 2023 DB Systemtechnik embarked on another journey with the test train for the digital automatic coupler (DAC). After modifications to the couplers and the electronic equipment, tests were carried out in Nuremberg, Serbia, Hungary and Austria in shunting operations and on various lines.

This involved testing the train's new electrical equipment, which has been converted from 110 volts direct current to 400 volts alternating current. This enables additional digital applications such as freight monitoring and automation functions for the freight train of the future.

The tests also included the trial of technical refinements to the couplers made by the manufacturers Voith and Dellner after the second phase of the trial. In the previous phase, the couplers were tested in various running situations and climatic conditions in several different countries.



More information on the DAC4EU European consortium at:  
**[www.dac4.eu](http://www.dac4.eu)**





## Millions of euros in funding for **RailCampus OWL** in Minden and start of term for the Digital Railway Systems degree course

In June 2023, the Budget Committee of the German Bundestag approved funding for a research project on the future of mobility at RailCampus OWL (DB Systemtechnik site in Minden). Funding of 12.5 million euros has been earmarked for the first phase of the project, and long-term financing has been secured until 2027.

At RailCampus OWL, one of four locations of the German Centre for Mobility, intensive research is being conducted into the digitalisation of rail transport through the development of innovative technologies. The project is dedicated to researching technological systems, components,

methods and validation procedures related to automatic train operation (ATO). Questions about user acceptance of new technologies will also be addressed. The focus is on the area around Minden railway station as an example, with the aim of transferring the results to comparable rural areas.

**By the way:** in October 2023, we welcomed another cohort of students who are embarking on the Digital Rail Systems degree course.

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## Success for noise control: 25 years of "Specially Monitored Track (SMT)"

The issue of noise control is important to us. The SMT method represents a noise reduction technique that was developed for the early detection of rail running surface defects, known as rail corrugation or rail roughness. Applying the SMT method leads to a permanent reduction in rolling noise.

The DB Systemtechnik noise measuring train has been travelling on DB Netz lines across Germany for over 25 years now to monitor the busiest lines. Using a measuring method specially developed for this purpose by DB Systemtechnik, acoustic measurements are used to specifically identify sections of track that exhibit increased rail corrugation. These are then subjected to rail machining according to the SMT process.

Work on developing this process began before 1990 and was aimed at permanently guaranteeing a smooth rail surface to minimise rolling noise. In 1998, the "specially monitored track" procedure was officially recognised by the EBA. As a result, after more than one and a half decades, the SMT method was introduced as a recognised noise reduction technique in the regulation for calculating the noise rating level on railway tracks in the current Schall (Noise) 03 (2015) regulation.

The SMT procedure has proven to be a lasting success for noise control and helps to minimise noise pollution in rail transport.





## Five trains in just four months: review of the tests with the Franconia–South Thuringia Express in 2023

DB Systemtechnik has completed its extensive tests using the new six-car Desiro HC multiple units from Siemens. The trains are to be used to modernise regional transport on the Franconia–South Thuringia network as from June 2024 and will even run on the Berlin–Munich high-speed line.

The tests were carried out simultaneously using five Desiro trains on the German rail network. Test results were collected for approval and special requirements such as the ETCS train protection system were met.

Jörg Neugebauer, DB Systemtechnik project manager for the test campaign, reviews the measurement campaign:

"Testing from a single source – this was more than just a slogan for the Franconia–South Thuringia Express. We produced instrumented wheelsets, tested brakes, electromagnetic compatibility, interaction between pantograph and overhead line, aerodynamics, acoustics, running equipment and service strength within a very short period of time. Together with our test teams and rail companies, we overcame the challenges with planning and resource by implementing a detailed and efficient four-month programme of test runs."

Having successfully completed the tests, DB Systemtechnik has taken a big step towards modernising regional transport.





© DB Systemtechnik / Hans-Christian Plambeck

## Experiencing technology up close and finding the skilled workers of tomorrow: Apprentice Vibes Fair and Open Day at DB Systemtechnik in Minden

The Apprentice Vibes Fair took place for the first time on the premises of DB Systemtechnik in Minden from 11 to 13 May 2023. We also held an Open Day on 13 May 2023. Hosting the largest apprentice fair in the Mühlenkreis district was a unique opportunity not only to present our

company to talented young people but also to give interested visitors a look behind the scenes at DB Systemtechnik. A total of 120 companies were represented and we welcomed more than 6,000 visitors.





## Contacts

# Systemtechnik ESG

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# DB Systemtechnik – Management



**Hans Peter Lang**  
Chairman of the  
Board of Managing Directors

*"For us, no challenge is too great –  
we will overcome it together."*



**Christoph Kirschinger**  
General Manager  
Sales

*"Our clients come first and our work is  
always focussed on their success."*



**Stefan Schneider**  
General Manager  
Finance/Controlling and  
Human Resources

*"Your satisfaction is our top priority  
and we will do everything we can to  
ensure that you have the best possible  
experience with our company."*



# DB Systemtechnik – Business Lines



**Dr Burkhard Schulte-Werning**  
Business Line  
Maintenance Technology

*"We have a host of good ideas for your success!"*



**Dr Lars Müller**  
Business Line  
Approval/Testing

*"From engineering and testing through to approval: we are the full-range supplier of approval services"*



**Nils Dube**  
Business Line  
Engineering

*"Our mission is professional engineering to meet your challenges. In doing so, we emphasise sustainable customer benefits."*



**Rupert Lange-Brandenburg**  
Business Line  
Digital Products and Services

*"Combining railway engineering knowledge with the latest possibilities in digitalisation to create added value for our customers – that's the future!"*

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*"My goal is to be a reliable partner to our clients, building and maintaining a close personal bond and level of trust with every project we execute."*



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*"Our expertise represents your success – it accompanies you from the first draft design to successful completion of the project."*



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*"From the initial idea and the search for a suitable solution through to successful implementation, I am at the client's side and I do everything I can to ensure the success of a project."*



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*"My work is based on commitment and the passion to successfully realise international partnerships for you."*



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*"We stand for competency through diligence."*



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*"We are your independent partner  
for efficient solutions and Strong Rail."*



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*"Our competency and expertise ensure  
that you get the best result."*



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*"I stand for trust and empathy,  
as I build a bridge between your  
needs and our services."*



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*"Your satisfaction is my motivation!"*

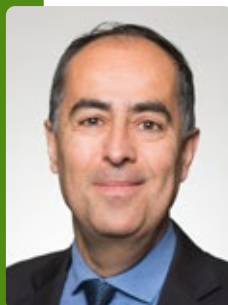


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*"With our expertise and passion for  
excellence, together we will shape  
a ground-breaking future for your  
projects."*

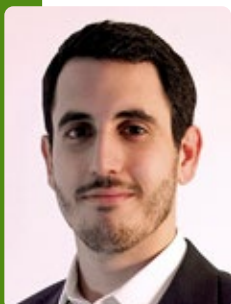


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*"Customer satisfaction is my  
top priority."*



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*"Your success is our top priority. With  
our support you can overcome your  
challenges."*



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*"With my commitment and expertise,  
I am at your side, delivering solutions  
for your requirements in Central and  
Eastern Europe."*

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*"With expertise and passion we are shaping the future of rail transport together with our customers."*



**Anna Traudt**

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*"I promise not just to sell a product to our customers, but to offer them a tailor-made solution."*



**Stefan Schroeder**

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*"Reliability and mutual trust are the basis for joint success."*



**Tobias Meyer**

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*"The secret of getting ahead is getting started. Let's start together now."*



**Samy Aouchta**

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*"We are not satisfied until you are, and that is how we can take your business further."*



# DB ESG



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*"I am proud of the performance of DB ESG in providing high-quality products and services to all our customers."*



**Kevin Dilks**  
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*"I enthusiastically support companies in realising their ambitions. In doing so, I attach particular importance to excellent customer service and high quality."*



**Yan Tao**  
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*"Successful international business always requires a very open world view and interaction with customers. That is what I can provide."*



**Sergej Samjatin**  
Director Sales,  
Marketing & Communication

*"Intercultural competency is the key to success in the field of business development. With my personal experience, I contribute to its development on a daily basis."*

## RAG railway approvals



**Dr Lars Müller**  
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*"As a railway service provider, we are pragmatic in our approach to achieving our goals: approved vehicles, infrastructure and control-command and signalling."*

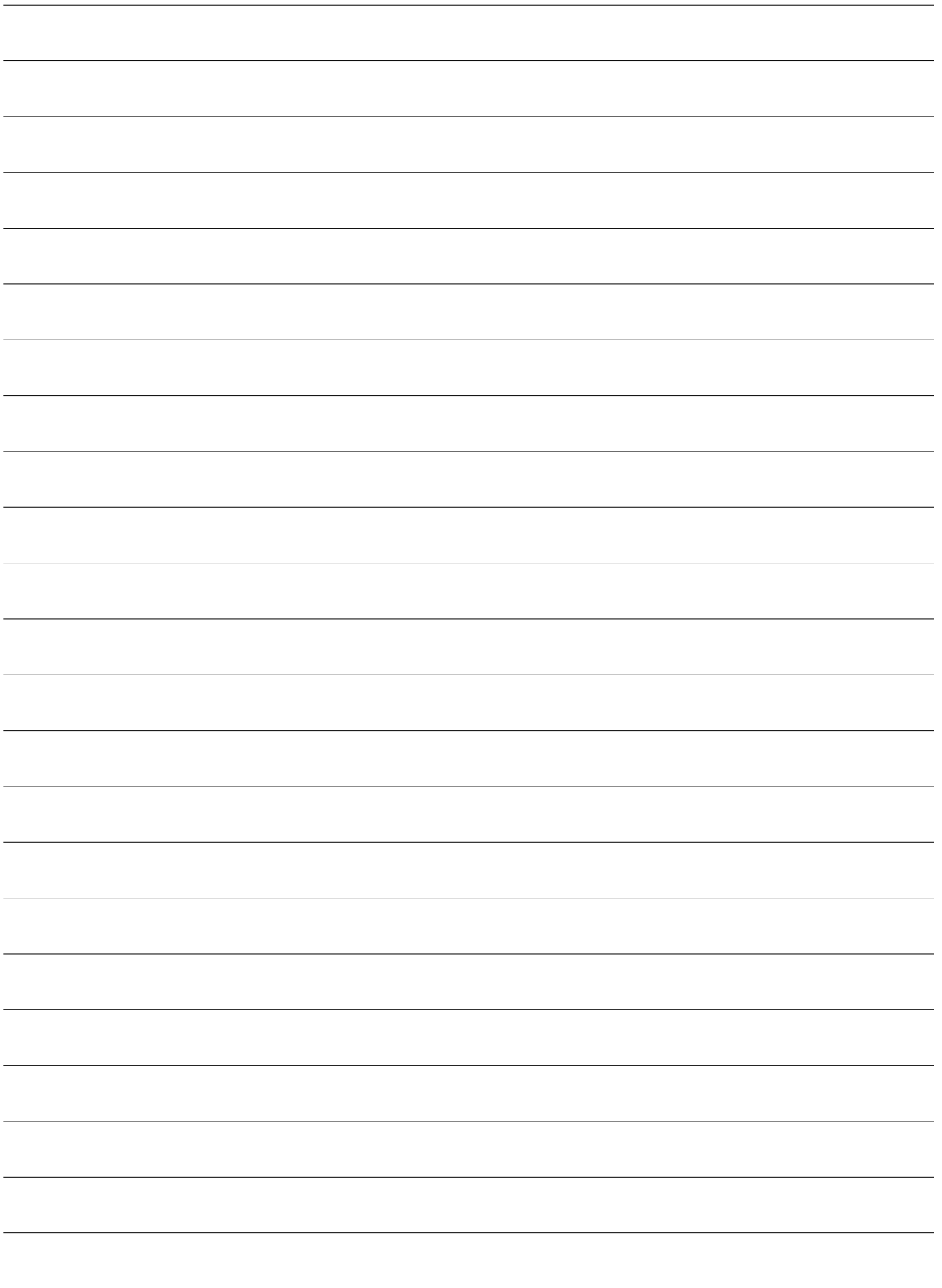


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*"In addition to creating safe products, the incentives for our team are satisfied customers and added value for the rail system."*

## Notes

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