

# Infrastructure for All Research Questions

**Companies and universities have a tradition of fruitful cooperation. In particular, joint research projects are realised on the various test rigs at TU Graz.**

**Birgit Baustädter**

**W**hen universities and companies do research together, both sides benefit. The excellent infrastructure with numerous test rigs, laboratories and test facilities at TU Graz makes joint research projects possible.

TU Graz Professor Hannes Hick sees the best advantages for companies in academic support for research and development issues: "Companies and universities benefit immensely from bilateral collaboration." According to Hick, this advantageous interaction starts with the students. Not only do they benefit from



The diverse research infrastructure at TU Graz offers answers to complex research questions. The picture shows load tests on cross-laminated timber at the Institute of Timber Construction and Wood Technology.

a practical education at the university through close cooperation with companies, they are also already very familiar with the corporate environment when they enter the job market. "In difficult project phases, our students and their motivated and flexible work force make research possible in the first place."

Ferdinand Pospischil, who works in the rail transport sector, takes a similar view: "Many fundamental research questions are time-consuming and cost-intensive. As a university interested in academic research, we take on these tasks for companies and thus



In 2024, TU Graz raised 89 million euros (including CAMPUSonline) in third-party funding – a large proportion coming from contract research and cooperation projects with companies.

Lunghammer – TU Graz



provide them with the basis or important additional information for specific product developments or improvements.” And Gerald Kothleitner from the Institute of Electron Microscopy and Nanoanalysis adds:

**“With our high-end infrastructure, we answer important specialised questions for a wide range of business sectors.”**

At the same time, corporate collaborations make research projects at the university possible in the first place – because they co-finance and utilise the infrastructure. Internationally, TU Graz is one of the leaders in terms of equipment, adds Hannes Hick: “The business location also benefits enormously from this in turn.”

### JOINT RESEARCH INFRASTRUCTURE

Hannes Hick himself runs the Transmission Center at TU Graz together with the company AVL. A research laboratory with a very special structure, the premises belong to TU Graz but the test rigs still belong to the company. TU Graz researchers carry out projects there on behalf of AVL, but also use the infrastructure for their own research. “We both benefit enormously from this. The university, because we can use an unbelievably great infrastructure together with one of the market leaders in the automotive industry. And AVL through cooperative research and because we can offer practical training for our students at the Transmission Centre,” he explains. He sees the collaboration with the large company as a successful model that can also be implemented with other companies interested in collaboration – both in the area of their own infrastructure on the TU Graz campus and in joint research projects on the existing infrastructure.

The Transmission Center examines CO<sub>2</sub>-reduced propulsion systems that run on electricity, hydrogen or synthetic fuels. This is a field that has come under pressure in recent years due to market developments in alternative drive technologies. “When completely new propulsion systems are developed, this has extreme lead times for the industry. At the time, a completely different development was expected, which did not materialise to the extent planned. As a research facility, we are countering this by picking out the particularly tricky issues and trying to solve the last hurdles in the development towards sustainable mobility,” says Hick, going on to invite interested companies to collaborate.

One example of such a tricky subject is tribology, which investigates friction and wear processes in order to determine the service life of components, among other things. This is particularly important in e-mobility because the revolution speeds are much higher than those in combustion engines. “This field of research is very interdisciplinary because it involves materials science, strength, hydrodynamics and much more. Our advantage is that we have all these specialisms at the university and can conduct research together.”

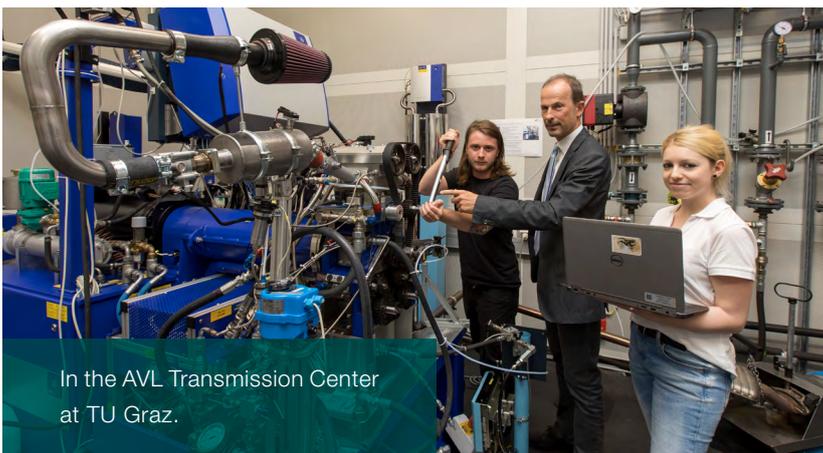
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DLL – In the Digital Lifecycle Lab, the product development process is mapped in a virtual cycle. The focus is on digital twins and system modelling. AI will also be incorporated into the developments. In addition, the institute has succeeded in establishing an internationally unique research infrastructure for “digital product development”, in which the product is model-based from the idea to realisation, thus enabling new approaches to product creation.

### SUPERSTRUCTURE TEST RIG

Ferdinand Pospischil, head of the Institute for Railway Infrastructure Design, also emphasises the advantages that TU Graz offers in the field of interdisciplinary research. “At TU Graz, we cover the entire railway system – from rolling stock to economic efficiency and superstructure (track).” Not least, ÖBB and voestalpine have already benefited from this research cooperation (see commentary on page 9). Research can be done on the broad fundamentals at TU Graz, the latter can then be implemented and brought to market maturity by railway infrastructure companies and suppliers.

Next year, a new superstructure test rig will go into operation at Pospischil’s institute, which will enable in-depth analyses of the ballast bed, sleepers and rails and their interaction. Pospischil wants to examine the effects of climate change on railway infrastructure in particular using the new test rig.



In the AVL Transmission Center at TU Graz.

For example, flooding can be simulated on the test rig. “With the new test system, we can examine in great detail what effects flooding has on the track and the vehicle and how to react to it in endangered areas.” The data from these tests can then be incorporated into a comprehensive simulation model together with tests from other institutes such as the Institute of Structural Durability and Railway Technology.

Measurements are taken both in the laboratory and on the railway itself. In the picture: Ferdinand Pospischil, Head of the Institute for Railway Infrastructure Design.



**“We can look at very complex systems in detail there because all the necessary tools are in one place.”**

This common whole is reflected above all in the Research Cluster Railway Systems, in which the three railway institutes and the Institute of Mechanical Engineering and Business Informatics at TU Graz work together with the Virtual Vehicle competence centre and the corporate partners ÖBB, voestalpine and Siemens.

Research Cluster Railway Systems

### BRAKE TEST RIG

Martin Leitner and the Institute of Structural Durability and Railway Technology are also part of the Research Cluster Railway Systems and are focusing on rail vehicles themselves. The focus is among other things on the underframe, the wheel-set shaft and, for a few years, also the brakes. The newly opened brake test rig is among other things used for friction coefficient tests, which are necessary for certification of a vehicle. “Our brake test rig is unique in this form and offers great opportunities in combination with other test options. “A special focus is placed on the lightweight construction of bogies while maintaining stability, load-bearing capacity and service life in order, for example, to make rail vehicles lighter and reduce the load on the infrastructure and the energy consumption.

The institute also operates the Fatigue Testing Laboratory, where, next to fundamental research, also bogies, current collectors and other important structures and components are analysed. “We carry out standardised tests with defined load cycles and under specified loads, which are then used to decide on whether approval can be given. In other words, if there are no cracks or similar in the component, then it’s good.”



All photos by Lunghammer – TU Graz

### BATTERIES UNDER PRESSURE

The Battery Safety Centre at TU Graz is all about the safety of batteries, as the name suggests. Different types of battery cells and modules are analysed on several test benches to see how they behave under various loads. This provides important knowledge about behaviour in critical situations, especially in accident scenarios. These findings are relevant for all companies that use electrical energy storage systems. And the mechanical tests are particularly interesting for mobile applications such as the automotive sector. Eva Heider, deputy head, summarises: “With our unique self-designed test benches, we want to advance research in the field of battery safety. We are working with innovative companies on new methods to increase battery safety in all applications.”

The test rigs are designed and in some cases built by the team themselves with their eyes on the emerging research questions and with a focus on expandability. At the moment, for example, the emphasis is on finding a successor to the Presto hydraulic press: “Student assistants are currently designing and constructing the test bench in the simulation under expert guidance. In the summer they will probably also assemble it themselves,” says head of the Battery Safety Centre Jörg Moser, explaining how researchers are already involved in the work at the Centre at the start of their careers. University project assistant Stefan Grollitsch is responsible for the project: “Thanks to the new test bench, we will be significantly expanding our testing portfolio and increasing measurement accuracy.” In future, for example, the press will be



able to pressurise battery cells up to a certain degree and then charge and discharge them there. This is important, for example, when it comes to whether it is possible to continue driving after an accident or other mechanical impact.

For Eva Heider, however, measurement accuracy is essential: “Our laboratory, the Battery Safety Centre Graz, and our test benches are truly unique. They are designed in such a way that we can use the high-precision measurement results to run simulation models.” And Jörg Moser adds: “It has to be clear whether the effects are due to the load from the test itself and not because the test bench itself is buckling, for example. This is not such an easy task since the pressure plate alone weighs 1.6 tonnes and can exert up to 100 tonnes of force. However, we have developed a sophisticated measurement concept and can achieve so much in the area of design that the effects from the test bench are negligible,” he explains. At some point in the future, electrochemical impedance analyses (EIS measurements for short) will be able to be carried out in the new test bench. The aim is to find electrical parameters that enable simple, non-invasive statements to be made about the state of health of the battery cell.

“And, of course, it is always important for us that the test bench is thermally safe,” explains Moser cryptically. And he adds: “Because we also test our batteries fully charged until they fail.”

### TESTS TO IMPROVE VEHICLE SAFETY

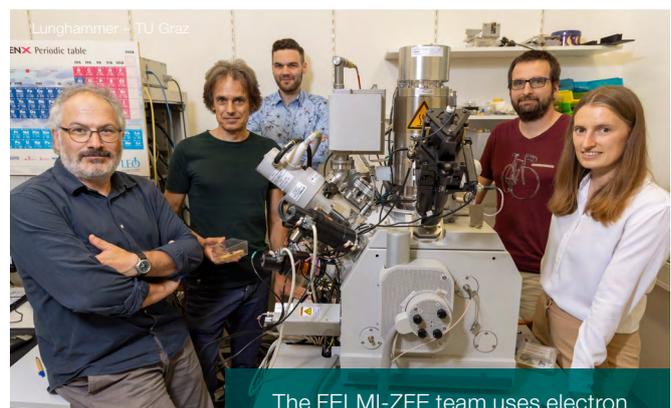
Corina Klug at the Institute of Vehicle Safety also deals with road safety. The focus of the research group is on the people who are in the vehicle as well as on those who are on the road outside the vehicles and their behaviour shortly before and during an accident. In the institute’s Crash Lab, her team carries out various tests and experiments on different scenarios in order to further improve simulations. One current topic, for example, is how differently female and male bodies are protected in vehicles, as Klug explains: “In previous studies, women’s bodies were often defined as smaller men’s bodies – which is not true at all

anatomically. However, too little consideration is still being given to these physical differences and the resulting changes to the occupant protection systems in the vehicle.”

A special test rig for volunteer tests is being used to investigate how the seat belt interacts with different body shapes during normal braking manoeuvres and in different seating positions. Gregor Gstrein is responsible for the experimental area in the research group and explains that the experiments are subject to strict safety measures to ensure that nobody is injured. Desirée Kofler, who has already conducted several test series here, reports that “the test subjects can distract themselves from the tests with small games in a virtual world and have a lot of fun in the process.” “It’s almost as much fun as riding a roller coaster,” says Corina Klug, who has also sat on the sledge a few times herself. Christoph Leo heads the FemTech FFG project FairOSA, in which a large series of tests with more than 60 test subjects is planned. “The data obtained from the tests can be used to further improve virtual human models and generate a better understanding of how to achieve optimal interaction between the seatbelt and different body shapes. There are now many possibilities thanks to camera systems in the vehicle and by specifically influencing the belt characteristics using belt tensioners and belt force limiters, and we work on finding the optimum solution to increase overall safety for everyone.”

### ELECTRON MICROSCOPES

“Electron microscopy is an key research tool,” says Gerald Kothleitner from the Institute of Electron Microscopy and Nanoanalysis at TU Graz. “It provides meaningful images of the structure of a material, which can be used in combination with spectroscopic measurement methods for extensive analyses.” Electron microscopes can be used to recognise atomic structures in the object under investigation, smallest quantities



The FELMI-ZFE team uses electron microscopes to look deep into the material structure.



## Comment

of elements and defects that give the material its properties. Using accelerated electrons that are scattered in the material, important material parameters can ultimately be determined, properties specifically predicted or systems designed. “The electron as a precise probe provides answers as to how atoms are arranged, what they are and how many of them there are,” explains Kothleitner, simplifying.

The complex high-tech infrastructure is cost-intensive both in terms of acquisition and operation, but enables fundamental answers to questions of materials science. Just before Christmas, research funds amounting to seven million euros were laid out on two new electron microscopes. The new devices are now being developed together with the manufacturing company. “Our aim is not to buy off-the-shelf products – that makes us a national and international beacon.”

The department consists of the university Institute of Electron Microscopy and Nanoanalysis and the non-profit Centre for Electron Microscopy. The institutions are currently working together with 130 national and international company partners from the semiconductor, metal, ceramics, electrical and other industries in 25 projects at the same time, a good half of which are being managed at TU Graz. “Commercial companies do a lot of standard research themselves, but if something is out of line, they come to us. We provide the scientific foundation and, not least, the training of specialists.”

### CONDUCTING RESEARCH TOGETHER

Joint projects with TU Graz are easy to initiate. First of all, contact must be made with the Research and Technology House or with a particular institute. The research question is worked out together and the method developed.

**“There is a lot of interest from business and industry, but of course there is always room for new joint projects,”**

says Hannes Hick with a smile.

He recognises the increasing importance of research and development in Europe, particularly in view of the market pressure from Asia and America.

voestalpine Railway Systems, a leading supplier of complete solutions for railway infrastructures, emphasises the crucial role of test rigs in the railway industry. They are essential to ensure the safety, availability and efficiency of railway infrastructure and its components. Close cooperation with research institutions such as TU Graz plays a central role in this.

**Innovative test rig technologies:** An outstanding example of innovation in this area is the new test rig being installed at the Institute of Railway Infrastructure Design. Modelling, analysis, validation of simulations and prediction/quantification of dynamic force flows and damage to elements and system structures of the railway infrastructure will thus be possible. The effects of the climate (e.g. flooding) on the railway track can also be simulated, thus optimising the system.

**Advantages of collaboration:** voestalpine Railway Systems recognises and appreciates the advantages of collaborating with research institutes and industrial partners. The exchange of knowledge and resources creates innovative solutions that advance the entire sector. The upcoming new test rig is an example of successful cooperation between industry and science.

**Future prospects:** The constant further development of test benches and test methods is essential to fulfil the increasing requirements for safety and efficiency. voestalpine Railway Systems is committed to actively shaping this progress. Collaborating with partners such as TU Graz makes it possible to research and implement new technologies that contribute to a more sustainable and efficient railway infrastructure in the long term.

**Conclusion:** Test rigs are indispensable tools in the railway industry. They make it possible to test and optimise the performance and safety of the track and its elements under realistic conditions. voestalpine Railway Systems emphasises the importance of collaboration with research institutions and industrial partners to develop innovative solutions and actively shape the future of railway infrastructure. The new test rig at Graz University of Technology impressively demonstrates how sustainable progress can be achieved through collaboration and technological innovation.

**Franz Sodja, CTO voestalpine Railway Systems**