

Automotive and Transportation

## FKFS

FKFS achieves a winning difference for its aeroacoustic wind tunnel from Siemens Simcenter

### Product

Simcenter

### Business challenges

Achieve augmented and high-quality test-based acoustic data to maintain the institute's competitive advantage

Adapt the testing capabilities for future EV development

Integrated solutions for testing vehicle exterior and interior noise simultaneously

### Keys to success

Implement integrated solutions allowing seamless exterior and interior measurements correlation

Full vehicle surface exterior noise measurements

Create straightforward access to results and clear visualization for the customer

Select reliable partner to ensure fast delivery and reduce downtime

### Results

Significantly increased testing efficiency per session

Achieved more detailed engineering results and insights

Delivered immediate results comparison and interactive on-spot vehicle optimizations

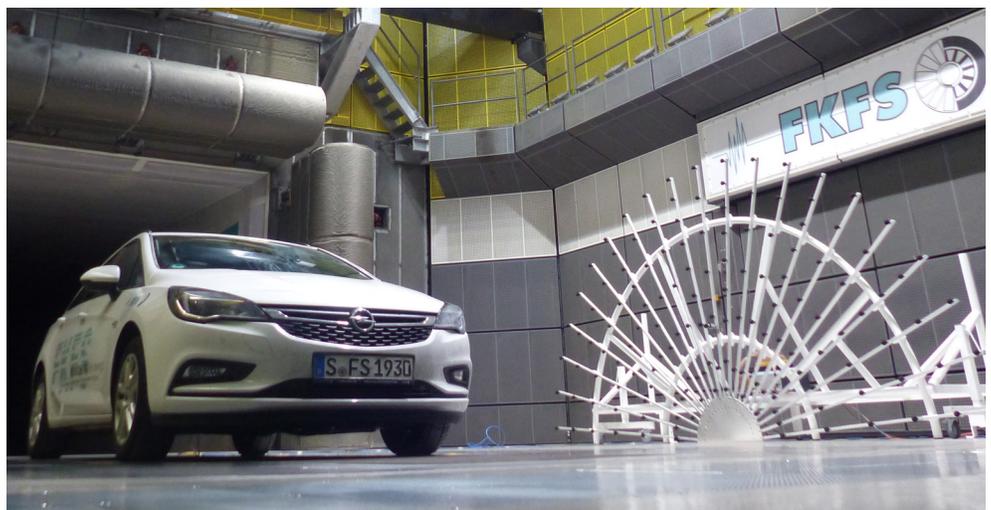
**FKFS offers highly efficient aeroacoustic wind tunnel testing and simulation services resulting in immediate vehicle advancements**

### FKFS: An important testing facility with a long history

The Research Institute of Automotive Engineering and Vehicle Engines Stuttgart (FKFS) is a well-established research institute providing testing, simulation and consulting services for the automotive industry. The scope of services comprises three parts: automotive engineering, powertrain and mechatronics. With extensive experience and almost 90 years of history in physical testing and simulation, FKFS has established a wide range of simulation and testing

capabilities to deal with more or less all parts of a vehicle for different development stages. Following standardized ISO-certified procedures, FKFS today offers, among others, services of four wind tunnels: full-scale aeroacoustics, model scale, thermal and a digital wind tunnel. Some of the testing facilities, such as a mechatronic driving simulator with two-dimensional sledge and hexapod, is the largest in Europe.

The objective of the aeroacoustic wind tunnel is to understand how the vehicle design shapes the wind noise perceived in the cabin. To achieve the required engineering insights, the vehicle is positioned in the full-scale aeroacoustic wind tunnel at different flow speeds and under different yaw angles while measuring the exterior sound pressure radiated by the vehicle surface. Together with the interior



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Dr. Reinhard Blumrich  
Head of the Vehicle Acoustics  
and Vibration Department  
FKFS



acoustic measurements, these tests unveil the acoustic leaks and points of improvement for attaining driver comfort.

Automotive manufacturers understand that the vehicle noise, vibration and harshness (NVH) performance defines customers' perceptions and has a direct impact on the purchase decision. For this reason, a significant part of the vehicle development budget is allocated to acoustic testing to master the final NVH performance.

#### **Advancing aeroacoustic vehicle development**

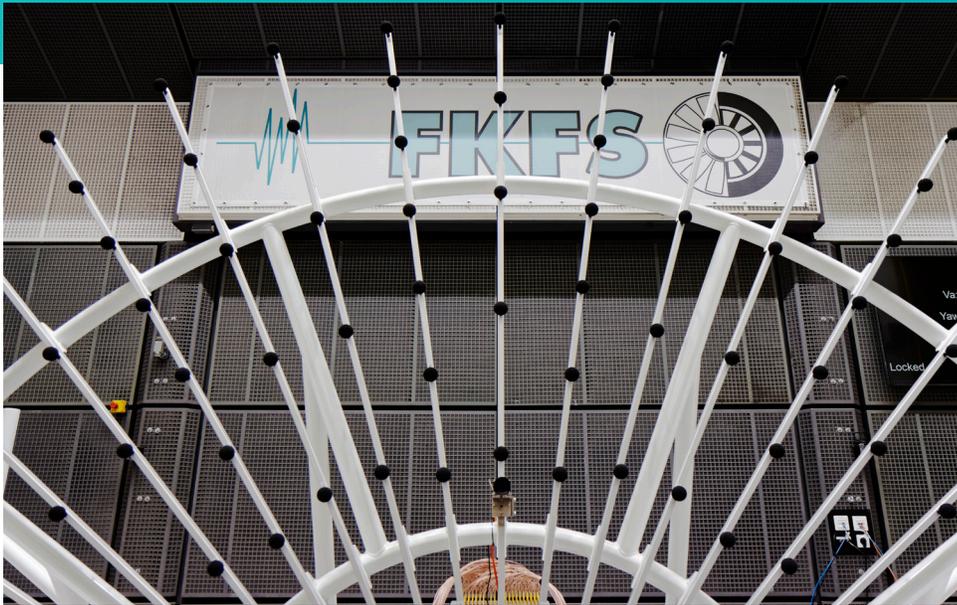
To counter increasing competition in the world, where the number of aeroacoustic wind tunnels increased in past years, FKFS decided to upgrade and extend its

aeroacoustic testing capabilities and invest in the latest and unique technology. “We are obligated to keep up with the competition, and the key is continuous innovation. Our customers had strong arguments that encouraged us to make this step,” says Dr. Reinhard Blumrich, head of the Vehicle Acoustics and Vibration Department at FKFS.

In 2019, FKFS replaced the existing array-based acoustic mirror with the latest aeroacoustic testing technology. “For aeroacoustics, it is still difficult to rely only on simulation,” explains Dr. Blumrich. “This kind of simulation is very complex and requires extensive time investments.”

***“With the new wind tunnel system in place, our customers can obtain much more information and more detailed information per testing session, even more than they expect.”***

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The new aeroacoustic wind tunnel testing system, deployed by Siemens Simcenter™ experts, consists of top and side microphone arrays including more than 300 microphones for the exterior sound pressure measurements as well as interior microphone arrays. This hardware is seamlessly connected with Simcenter™ Testlab™ software. “Now we can measure in one shot external and internal noise and correlate the results to see the coherence. Of course, this is much faster than before,” says Dr. Blumrich.

#### **Next-generation aeroacoustic wind tunnel**

Unlike the previous generation of the testing equipment, which mapped the sound pressure on the vehicle locally, the new top and side microphone arrays provide the 3D representation of the sound field of the entire vehicle in one measurement. “In 99 percent of the cases we investigate the final interior noise,” explains Dr. Blumrich. “On one hand, we measure the external noise, where the noise is generated. And on the other hand, we measure the interior noise with the internal array, artificial head and microphones to have the connection between what happens outside and how it is perceived inside. And this is one of the main benefits of the Siemens Simcenter solution, that you can combine the exterior and interior measurements in a very sophisticated way.”

This means that the vehicle design must be thought out and tested in detail, because each small design adaptation can have a significant impact on the final vehicle acoustic performance: consider parts like the A-pillar, side-view mirror, side windows, wipers and door handles.

“Our typical customers are vehicle producers, suppliers of, for example, sunroofs and windows,” says Dr. Blumrich. “It is very common that finding the best design of the sealing system, A-pillar, side mirror and windshield requires a lot of investigation.”

#### **Significantly increased efficiency per session**

The new technology applied in the wind tunnel opens new options for advancing the vehicle acoustic performance using “source-transfer-receiver” schematics. This approach separates the exterior sources from their transfer to the interior noise. This results in the ability to make informed decisions on how to best tackle the acoustic problem. For example, instead of adapting the door sealing design to avoid and block the final noise, this methodology identifies the possible adaptations of the noise source, such as changing the design of the side view mirror or wipers to avoid the noise generation. This approach provides FKFS and their customers with more ways to optimize the final acoustic performance.

In general, using the latest Simcenter wind tunnel testing technology, results that are obtained after a week of computational fluid dynamics (CFD) calculations can be achieved in a few minutes in the wind tunnel. The goal of this technology is to use advanced acoustic arrays to determine in real time the aeroacoustic pressure inside and outside of the vehicle.

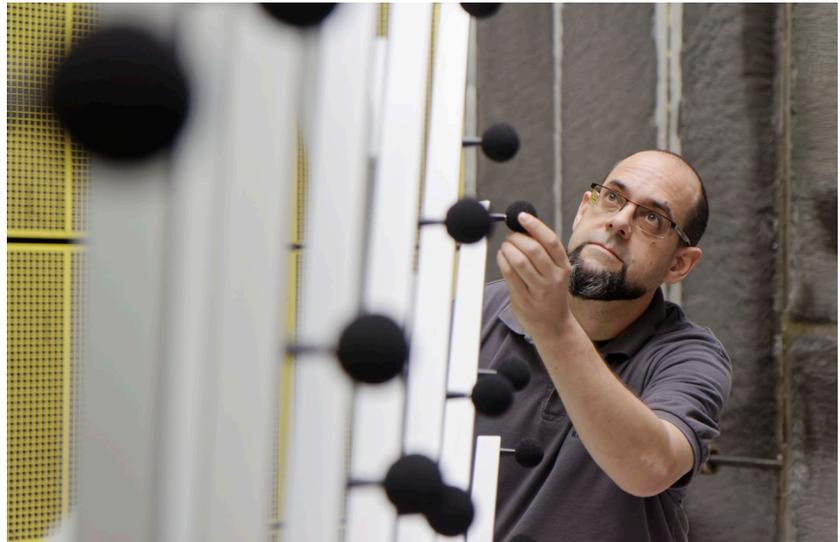
The test engineers usually begin by comparing different wind speeds and yaw angles (angles between flow and vehicle) and then proceed with design modifications to the vehicle. They can easily change different component variants and immediately compare the acoustic impact. The same applies to the interior parts like sealing systems at the front door and sealing around the entire car.

With the Simcenter wind tunnel solutions, FKFS engineers perform the measurements and access augmented and higher-quality information that enables customers to immediately evaluate the real-time results and interact. This was not possible in a short time frame with the previous approach, because of the limited performance, which prevented immediate vehicle adaptation. The new Siemens technology enables the development teams to make correct decisions during the wind tunnel testing campaign. "During a testing session, the client is typically together with our engineers in the control room," says Dr. Blumrich. "Our engineers carry out the test, and the client can

access the data immediately on a post-processing computer. The customers either follow their predefined testing schedule and analyze the data later, or they immediately proceed with some vehicle adaptation, like changing the antenna. It's a very close cooperation between the client and our engineers."

#### **Providing testing value to customers**

With the new Siemens Simcenter aeroacoustic wind tunnel system, FKFS increased testing efficiency by roughly a factor of two to ten, depending on the testing project and its scale. "With the new wind tunnel system in place, our customers can obtain much more information and more details per testing session, even more than they expect,"



***“It was impressive. Despite the short deadline, Siemens managed to deploy everything in time.”***

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## Solutions/Services

Simcenter SCADAS  
simcenter.com/  
simcenterscadas

Simcenter Testlab  
simcenter.com/  
simcentertestlab

## Customer's primary business

FKFS is a research institute providing testing, simulation and consulting services for the automotive industry with highly specialized test benches, wind tunnels and self-developed measurement, testing and simulation methods.

## Customer location

Stuttgart  
Germany

explains Dr. Blumrich. The 3D representation of the sound field accelerates the collaboration with the client. "This brings a great service that enables the client to have a better look into the sound field in the car or on the exterior."

Automotive OEMs benefit from this technology by testing more vehicle variants with the same testing time investments. This upgrade brought new customers to FKFS, and the new testing equipment is extensively used and booked out for months. "There are even night shifts every other week to cover the demand," says Dr. Blumrich.

## Aeroacoustic testing for electric vehicles

The decision to upgrade the aeroacoustic wind tunnel reflects the current trend of vehicle electrification. The absence of a loud combustion engine in hybrid and electrical vehicles, besides the tire-road noise, makes the aeroacoustic noise sources much more audible. "Because of the relative decrease of powertrain noise, the tire-road noise and aeroacoustic noise increases in relevance." Dr. Blumrich says. "And it increases the need for aeroacoustic measurements. If you remove the noise sources like combustion powertrain or side mirrors, human hearing will start to focus on other noise sources, which means that it becomes important to investigate and optimize other parts."



## Fast project delivery and deeper collaboration

In general, extending an existing system with a new one doesn't only involve financial investments for the new system, but also the financial loss of missed projects during the reconstruction. This is an important supplier selection aspect, especially in testing institutions where every hour counts. Reviewing this project, Dr. Blumrich appreciates the project delivery and ways of cooperation. "It was impressive," Dr. Blumrich says. "Despite the short deadline, Siemens managed to deploy everything in time. In addition, Siemens offered additional cooperation projects for further enhancements of the system after the installation. We have a common understanding to start joint research projects in this respect. That was another reason why we selected Siemens as a partner."

FKFS has further developed its toolbox for optimizing the interior noise by focusing on the unsteady aeroacoustics, wheel rotation, and ground simulation for a correct underbody flow with respect to the upcoming trend of autonomous vehicles.

## Siemens Digital Industries Software

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