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Maximum engine performance in competition

TOYOTA GAZOO Racing put their trust in Kistler when it comes to engines developing

Just a few kilometers left to the finishing line. Jari-Matti Latvala hopes he can still overtake his rivals in the last couple of kilometers to sweep the TOYOTA GAZOO Racing Team to victory. He already has over 300 kilometers of the snow-covered rally route behind him. Now comes the critical moment: the driver in front of him grazes a concrete wall in the fourth-to-last test, and ends up stranded with a broken steering system. Latvala seizes the opportunity to take the lead, which he defends right up to the finishing line – so it's victory for Toyota in the 2017 Rally Sweden! An engine has to be optimally developed so that it can operate efficiently and smoothly under such extreme conditions as these. And that's why Toyota's racing professionals put their trust in Kistler when it comes to developing the engines for their rally vehicles.

Toyota can look back on more than seven decades of experience in motor sport. The Japanese automobile manufacturer groups its various motor racing activities together under the TOYOTA GAZOO Racing umbrella. "Overcome every obstacle to build better cars, and develop new technology and solutions under the extreme conditions of motor sport": that's the motto for the many teams of dedicated experts who constantly strive to optimize the engines at Toyota Motorsport GmbH in Cologne.

Back at the top after 17 years

TOYOTA GAZOO Racing's return to the FIA World Rally Championship in 2017 after an absence of 17 years couldn't have gone any better: team leader and world champion Tommi Mäkinen and his crew can claim credit for two outright rally victories and third place overall (as of November 2017). At first, nobody believed that such a success was possible: "2017 was actually intended as a development year, but the team couldn't have wished for a better start in the championship."

Measurement technology must meet enormous requirements

The foundations for the Japanese rally team's success were laid in 2016, when Toyota decided to opt for Kistler's measurement technology to develop its engines. "The engine is the beating heart of the vehicle. Alongside the rally driver's personal skills, it's the engine's performance that makes the difference between victory and defeat in competition. That's why we – together with our partner, Kistler – devote our absolute attention to it," Mäkinen explains. "Rally cars have to meet enormous requirements, so the measurement technology has to be suitably reliable and rugged."

Mobile solution for 100% test results

In the past, the Japanese automobile manufacturer used to carry out all its engine testing on the test bench. Martin Gerhardt, Senior Engineer R&D at Toyota Motorsport GmbH, explains: "We



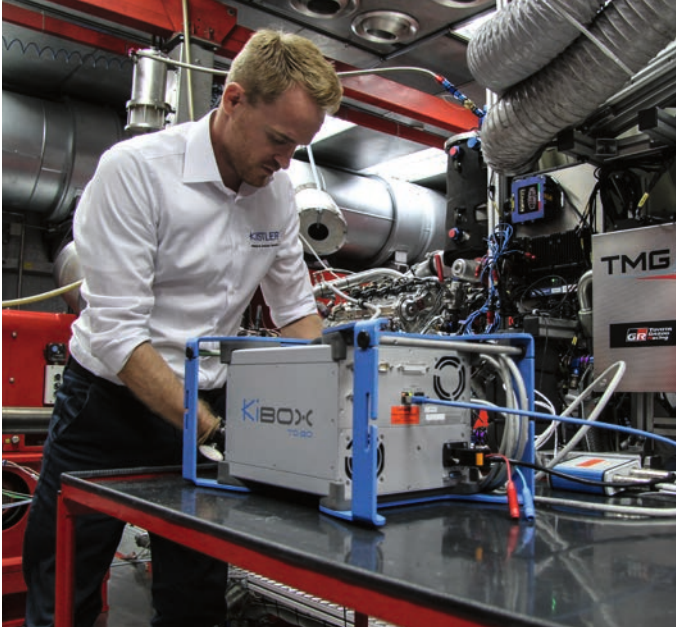
Rally cars have to meet enormous requirements. During a total of 13 races, motor sport professionals drive over gravel, asphalt and snow. (Source: TOYOTA GAZOO Racing)

were able to simulate numerous scenarios on our test systems, with exhaustive testing of our engines' performance. But those simulations couldn't provide 100% replication of the reality, so we started searching for a mobile solution that would allow us to test and optimize maximum engine performance under real conditions." The search mounted by Gerhardt and his team eventually led them to Kistler's KiBox.

This tried-and-tested indication system combines all the hardware and software needed for data acquisition in one compact, intuitively operated measuring system. It delivers detailed information on combustion quality in each individual cylinder, and makes all the relevant key data for engine development available in real time. Another benefit: this flexible system is equally suitable for mobile use and for test bench applications. Even with high g-forces and accelerations, the KiBox delivers reliable measurement data – making it the perfect choice for motor sport. What's more, operating temperatures ranging from 40°C during rallies in southern Europe to –20°C in Scandinavia present no obstacles for KiBox.

All-round on-site service caters to every need

The Toyota Yaris WRC rally car underwent several months of preparation for the test phase before the World Rally Championship season began. The compact KiBox indication system was also installed in the vehicle and commissioned.



When it comes to developing the engines for its rally vehicles, TOYOTA GAZOO Racing puts its trust in Kistler's measurement expertise. (Source: TOYOTA GAZOO Racing)

Tobias Strobel, System Test Engineer at Kistler, flew directly to the customer in Spain so that he could support the team on the ground: "Service is a top priority at Kistler. That means we don't just sell our sensors and systems – we go on to make sure that they are optimally installed, connected and configured."

Ideal conditions for engine testing

As soon as the KiBox was successfully commissioned, the TOYOTA GAZOO Racing team was able to tackle the test phase. "We wanted to make the conditions for our test as realistic as possible, so we chose a section of road that is part of the Rally Catalunya. That gave us ideal conditions for testing our engine's maximum performance," Gerhardt explains. The Spanish police closed off the section for the entire test.

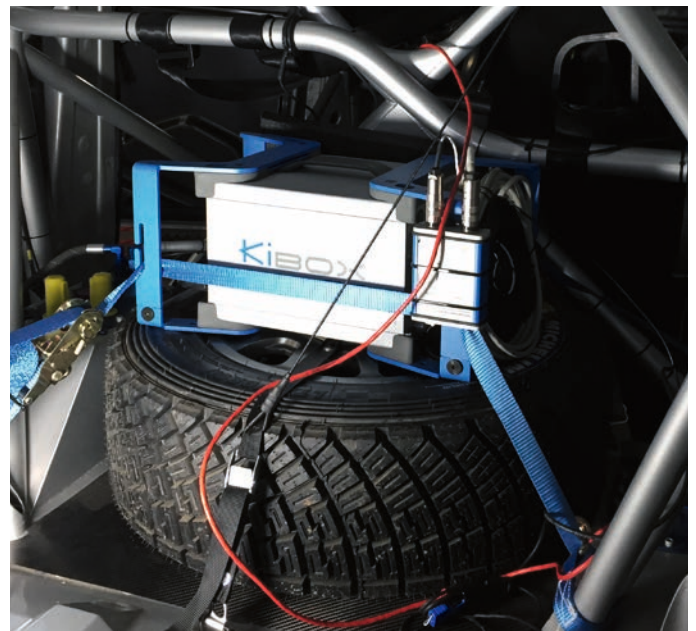
Maximum engine performance – thanks to KiBox

A rally driver completed a total of four test cycles with the Toyota Yaris WRC. During the drives, the KiBox recorded time- and angle-based cylinder pressures in detail, together with other relevant key data for engine development. In parallel, all data was calculated in real time and transmitted directly to the engine control unit.

This information delivered valuable insights into combustion quality in terms of performance, efficiency and emissions. The simple, easy-to-understand KiBox Cockpit software was then used to evaluate the captured data with the help of clear visualizations. The result: thanks to the data evaluation graphs, Strobel and Gerhardt were able to detect severe knocking in the engine. "Kistler's integrated pressure sensors and the KiBox enabled us to identify dangerous pressure peaks at the operating points. Had they gone unnoticed, they would have caused engine damage in the long term – resulting in high costs and loss of critical points in the competition," Gerhardt points out.

Into pole position – with Kistler

After the tests, the TOYOTA GAZOO Racing Team optimized the ignition timing, so they were able to boost their engine's performance substantially – a strategy that has so far paid dividends in the World Rally Championship. "Kistler's KiBox gives us a compact system that's quickly ready to operate, and it means we're much better able to analyze our engines. The device is very flexible to use, and it gives us added efficiency in tests. So now there's nothing to prevent us from continuing to ride our wave of success," Gerhardt sums up. Excellent collaboration and critical expertise as regards engine combustion: the Toyota team knows that it can count on these benefits from Kistler's measurement technology as it heads into the next rally season.



The Toyota Yaris WRC was prepared for the test phase before the World Rally Championship season began. The compact KiBox indication system was also installed in the vehicle and commissioned.

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