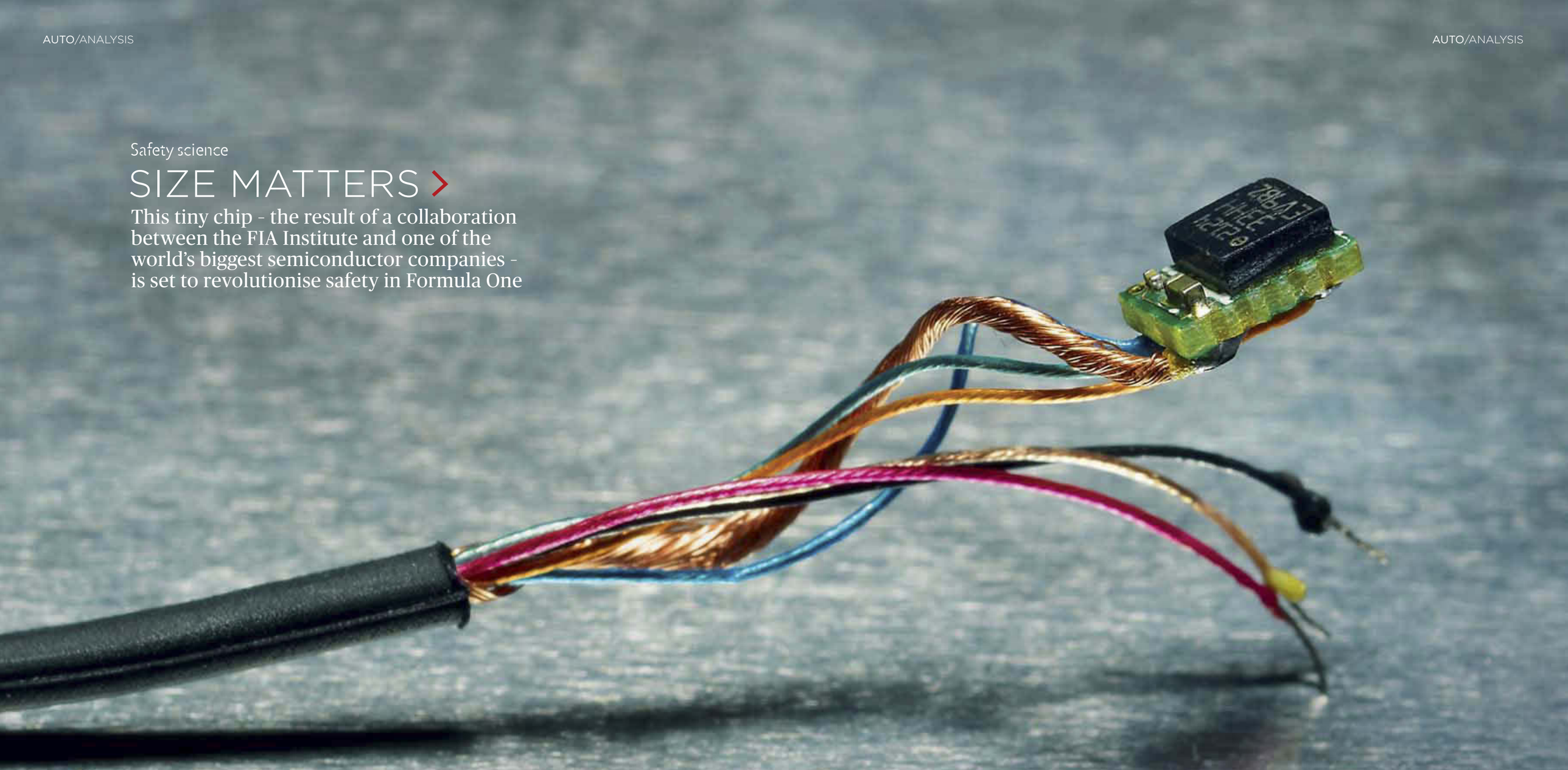
AUTO/ANALYSIS

Safety science

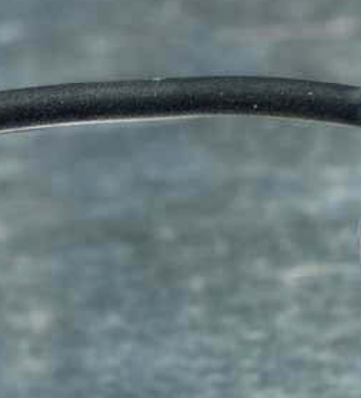
SIZE MATTERS ›

This tiny chip - the result of a collaboration between the FIA Institute and one of the world's biggest semiconductor companies - is set to revolutionise safety in Formula One



PHOTOGRAPHY: WILL THOM

This sensor – an accelerometer that's only a few millimetres across – will deliver vital instant impact information to help researchers understand driver injuries during a crash ›



The chip is housed in a silicon gell moulding tailored to the ear-canal shape of individual drivers. Such a snug fit will ensure highly accurate readouts of head acceleration and deceleration during an accident

A tiny chip is about to make a huge impact on motor sport safety. Just 3mm wide, it may be smaller than a matchstick head but within that space sits some serious engineering that could ultimately save lives.

It's an accelerometer of the type you might find in any smartphone or other mobile device that senses movement or acceleration. But this one has been specifically designed for use in sport. Working in conjunction with STMicroelectronics – a $9 billion turnover company that makes components for many consumer devices – the FIA Institute has adapted the sensor for use by racing drivers.

The sensor will be implanted in the driver's earpiece and inserted directly into his ear canal. It measures acceleration across three axes and continuously captures data about the forces acting on a driver's head, which is especially important in an accident. The data is delivered in real time and provides vital information for trackside doctors as well as safety researchers looking to make improvements.

FIA Institute research consultant Andy Mellor, who is leading this project, believes it could lead to a major breakthrough in safety research. "There is so much we can learn from a crash if we have the right information," he says. "For the last few years we've relied on Accident Data Recorders and these have given us hugely important information after a crash. However, they only tell you about the forces acting on the car. So the possibility of tracking the motion of the drivers themselves is a major breakthrough. The information from the accelerometer could give a precise kinematic of the head and the timing of the head movement during an accident."

Currently the only way for safety researchers to study the forces on a driver's head is to conduct a full-scale sled reconstruction in a test lab. The results are effective but take a long time and are extremely expensive. This tiny sensor will hugely speed up that process.

Mellor says: "In high-*g* impact accidents, such as the one suffered by Sergio Perez at the 2011 Monaco GP, you could have the information immediately. Doctors could use it to potentially assess what course of intervention they might need to take. Safety researchers could know straight away whether more work should be done on things like head rests or seat positions. It will all add to our knowledge base."

This new information could have a major influence at the top level of motor sport, from car design to equipment manufacture.

Mellor adds: "Just having that knowledge will take us into a world we haven't really been in before. Ultimately it will be helping us to design better cars; to make better safety equipment such as harnesses and helmets; to improve the positioning of the driver within the car with better seats, surrounds and side support."

The idea for the project was presented by Mellor almost 10 years ago. But only now has technology caught up with the theory.

Mellor first became involved in the project in 2004 when the Indy Racing League was using a larger accelerometer fitted on the outside of the driver's ear-piece. The FIA Institute did a detailed study back then and found that although the results could be useful, there was a significant decoupling between the head movement and data from the device. Mellor's endeavour was to find a device so small that it could go deeper into the ear canal to ensure more accurate results. After a couple of false starts, he was introduced to STMicroelectronics by a colleague two years ago and that's when the project gained pace.

'THIS KNOWLEDGE WILL TAKE US INTO A WORLD WE HAVEN'T BEEN IN'

ANDY MELLOR

The chip is so small that it will become an integral part of a driver's earpiece. So much so that Sebastian Vettel (left), won't even notice that he is carrying a potentially life-saving extra piece of equipment

Mellor says: "ST was right on the ball with the tech we needed, even though they didn't make the part we wanted at the time. From the moment we sat down with them it was obvious they had exactly the technology platform we needed." The resulting sensor is based on a platform part that ST mass-produces for smartphones. It is, in fact, this market that has driven the technology forward. Apart from its size, the major difference with this new sensor is how it measures loads.

Marco Ferraresi, business development manager for ST Motion MEMS in automotive and custom industrial applications, explains: "The FIA Institute's specification for the accelerometer was that it had to be very small to fit into the ear canal and we were able to produce that kind of miniaturisation. We started with an off-the-shelf sensor for preliminary try-outs. After a couple of years we managed to develop a sensor with the right specification, not only in terms of size but also in being a high-*g* accelerometer that will detect the impact a driver is subjected to during the race."

This was no easy task. Normally these sensors are used for low-*g* applications, such as measuring whether a mobile device is the right way up for for apps and games. But for this usage the input is limited to less than 10g. For head impacts in Formula One the measurements peak at 400*g* across all three axes – inputs that are instead closer to the *g*-ranges that are measured during car crashes and trigger the deployment of the airbags

The new chip is specifically designed to deal with such forces. Mellor explains: "It's a micro-electro mechanical system, so if you look at it under an electron microscope you don't see wires; you see what look like little structures. If you imagine it to be like a children's playground, you've got three little spring-riders that respond to movement. If a child sits on the normal design, a slight push will start the child rocking. However, if we replaced the spring with a stiffer one, a much bigger push would be required. The three spring-riders are mounted at different orientations to respond to motion in three directions: forwards-backwards, left-right and up-down."

Mellor is now confident that the new sensor is ready for the next stage of testing, which is to begin trialling it with F1 drivers. The F1 ear-piece is already a platform for driver communication with the teams, and the chip would be embedded alongside the speaker tube so there will be no discernible difference to the elite driver. But the information it provides could be of profound importance.

Mellor says: "We want to engage with the teams through the F1 Technical Working Group and validate it for F1 this year. We'll also do a final validation of the system from a mechanical point of view. By summer we'll know how to integrate it and the value of the data.

"We've got a brilliant partner in ST and it's something we're really confident about. We hope to be running this in F1 next season." ▫