PRESS RELEASE

Tracking down covered motor-doping in cycling

By now, it is well known that e-doping, also common as motor-doping, is a real and urgent threat in cycling. The issue occupies a considerable part in the discussions around the 103rd Tour de France. The struggle of the *Union Cycliste Internationale* UCI against minimally invasive technical doping systems is to be intensified further and brought to a sustainable basis: High forfeits, long-term bans and the search for effective uncovering methods. For this struggle Fraunhofer IZFP provides adequate tools to detect hidden auxiliary motors.

Since at least in January 2016, when the potential technical fraud attempt with a hidden electric motor was uncovered and the concerned athlete, the 19-year-old Belgian cyclo-cross rider Femke van den Driessche was punished with a ban by the UCI, it should be obvious to everyone: Motor-Doping is no mere rumor nor an unjustified presumption but bitter and sad reality with the potential to seriously damage cycling. "This problem is worse than doping, the future of cycling is at stake," says Thierry Braillard, the French State Secretary for Sport. But how to counteract this threat in the context of such a complex sporting mass rally with its immense logistical event structure? And even worth, if latest reports are trustworthy, the electric auxiliary motors in the saddle tube are obsolete, because an already available technical doping medium based on an electromagnetic drive is much more quiet and unobtrusive: Here, the rear tire rim is "doped" with appropriately positioned magnets. This is about the same technique as used in the German maglev Transrapid – the so-called transverse flux motor.

But even beyond electromagnetic gears further options for energy conversion are perfectly conceivable from a purely technical point of view – and thus unfortunately from a view of abusive and manipulative use as well. So in the recent past prototypes of alternative low-emission motor vehicle gears have been tested that either use mechanical means for storage and energy recovery or use pneumatic accumulators for gear support. Therefore it is crucial to provide an optimized all-purpose strategy for the use of non-destructive inspection methods to reliably detect and prove hidden motors of any kind in cycling.

In this context the Fraunhofer Institute for Nondestructive Testing IZFP in Saarbrücken can put things right, because the institute offers measurement and inspection equipment covering different physical methods to detect any hidden mini-motors quickly and

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effectively: In a recent ARD TV report researchers and engineers of this Saarland research institute demonstrated some solutions to detect hidden electric auxiliary gears in racing / cross cycles for proving motor-doping in professional cycling. "Our researchers and engineers are concerned about concepts and solutions for the inspection of racers in professional sport as a pre-requisite for measuring and monitoring procedures to ensure fair cycle racing technology," explained Prof. Dr.-Ing. Bernd Valeske, Head of Fraunhofer IZFP's NDT of Components and Assemblies department and deputy director of the institute.

Hereinafter, Fraunhofer IZFP gives an overview on technical possibilities, basing on its experiences in scientific research, development and implementation of monitoring and inspection systems in industrial environments. In industry safety and quality of technical systems are main aspects of interest, but the required measurement standard in professional racing sport is pretty much identical. Considering the user requirements, the task is to select or to combine the most fitting methods from a huge range of possible systems. From an application perspective, the inspections should be easy to undertake providing mobile, fast, inexpensive and reliable handling while not impairing the test object. These automated and assisted inspections are to be performed by trained surveillance personnel. In the frame of the Tour de France this job is taken by so-called "Commissaires".

There are two principle ways of measuring, a passive and an active one. In case of passive measurement sensors / inspection equipment detect signals emanating from hidden auxiliary gears no matter if the gear is in active or inactive mode. These signals are traceable in the environment of the bicycle. The test instrument with integrated intelligent data analysis using latest methods of pattern recognition indicates an anomaly in the bicycle and visualizes it. In case of active measurement the inspection system itself irradiates signals whose echoes are altered or disturbed by hidden engine designs. Physical basis of these methods are electrical, magnetic, thermal or mechanical effects and combinations of them. In addition, the methods follow a triple design: First, they are not harmful to humans. Second, they work contact-free and thus can be performed from distance and with mobile inspection devices. Third, they work on large scales and are able to produce visualizations.

In both cases a promising approach provides scrutinies both before the start and after the finish. This comprises every wheel and wheel tire to be gone into action including all spare parts. Additionally, during the race a tight monitoring of the bike and the biker is to be performed from the curbside or on the road. The strategy can be complemented by entrained tracking bracelets with integrated sensors.

Hereby, manipulations will be detected with certainty and, thus, can be impeded.

The first approach – signals emitted by hidden gears with mechanical load transmission – uses acoustic anomalies in comparison to "clean" bicycles. These anomalies are recorded while the racers drive past gauging stations, which are equipped with sensitive

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microphone arrays and appropriate signal processing. Here, the acoustic signature analysis can filter out ultra-fine irregularities.

A further method demonstrated by Fraunhofer IZFP's experts is the thermographic inspection with infrared cameras (thermal imaging cameras). These cameras are sensible to minimal thermal changes up to 0.05 °C, caused by interaction between the frame and an electric motor or battery (see figure 1). "A safe detection of properties should be complemented by intelligent evaluation of the inspection signals performed by trained personnel," Prof. Valeske explains.

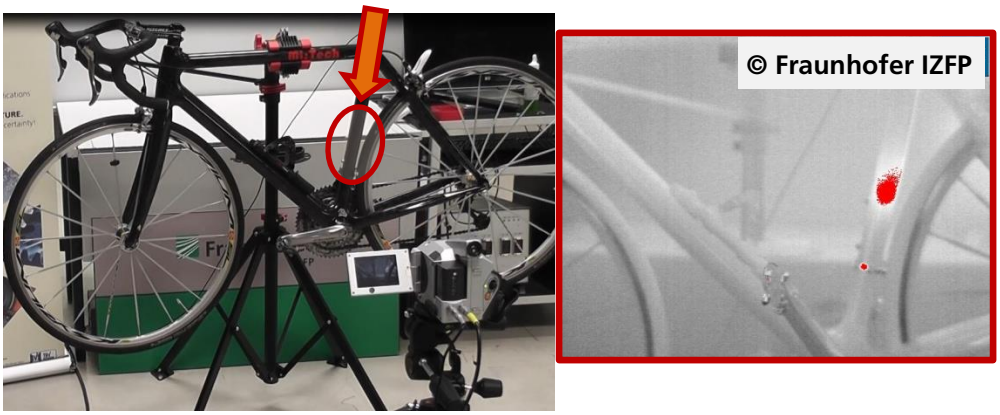

Figure 1:
Thermographic inspection of a racer with hidden electrical motor

Result:
Infrared image (thermal image)

Magnetic probes are easy to use and inexpensive. In form of so-called fluxgate sensors they are able to detect even smallest magnetic fields (that is, also from a switched off electric motor). After the bike (frame, wheels, and mounted parts) is scanned by such probes conspicuous magnetic features are displayed on a tablet or other display devices. Again, the signal processing of the detected measurement signals is handled by a software to give inexperienced users an even better basis to assess the physical measurement result compared to the oscilloscope signal of the physical original data as used by scientists (see figure 2).

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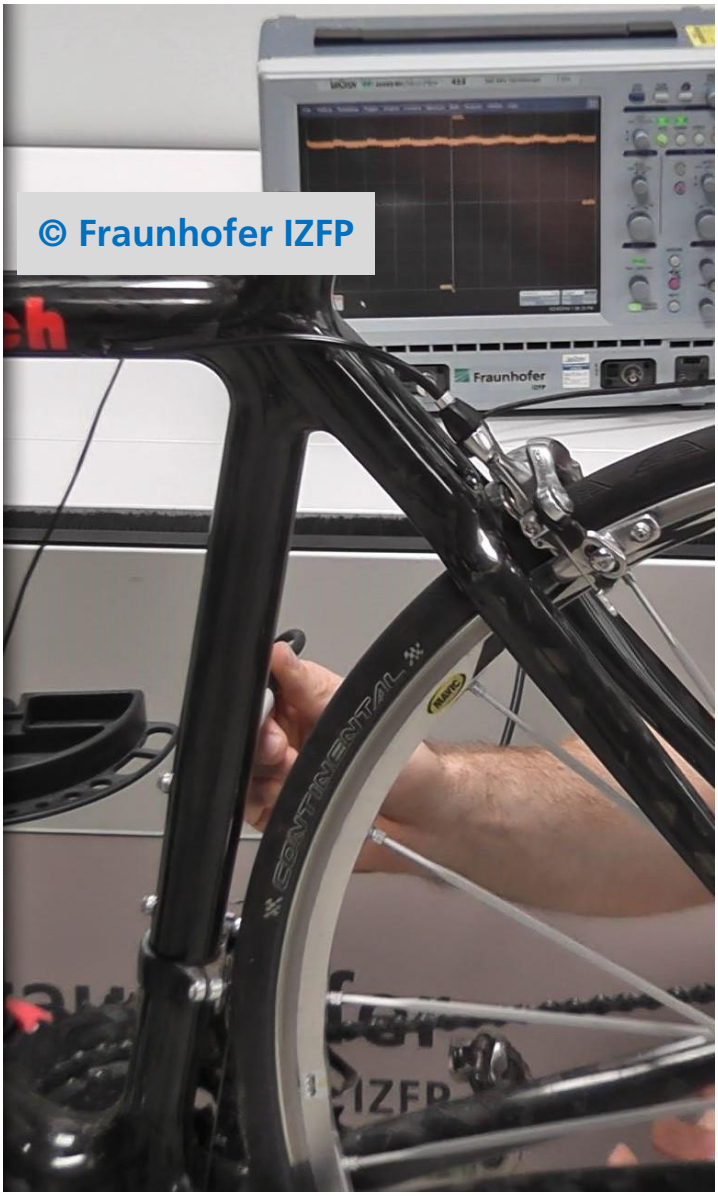

Figure 2: Magnetic field measurement with manual probe

A simple multi-step inspection strategy counteracting electric motor doping is based on the assessment of signals from thermographic cameras and magnetic field probes. In a next step, wheels showing conspicuous features can be finally characterized using additional nondestructive inspection methods such as modern digital X-ray techniques (digital radiography, see figure 3) developed by Fraunhofer IZFP. By these methods

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hidden auxiliary gears can be displayed very reliably even in case of locations within the volume of the bicycles. By request, this visualization can be provided three-dimensionally too. And of course this methods works without danger of impairments for humans and environment. These modern digital radiographic systems can be stowed easily in measurement vehicles. Under terms of a General Operating License they can be applied at different locations even without the often assumed safety precautions by specialized personnel. The physical principle is similar to "luggage scanners" as they can be found in airports. In this case too, the evaluation process can significantly be simplified and the evaluation results can significantly be enhanced by an automated evaluation software. Fraunhofer IZFP is specialized in this kind of software.

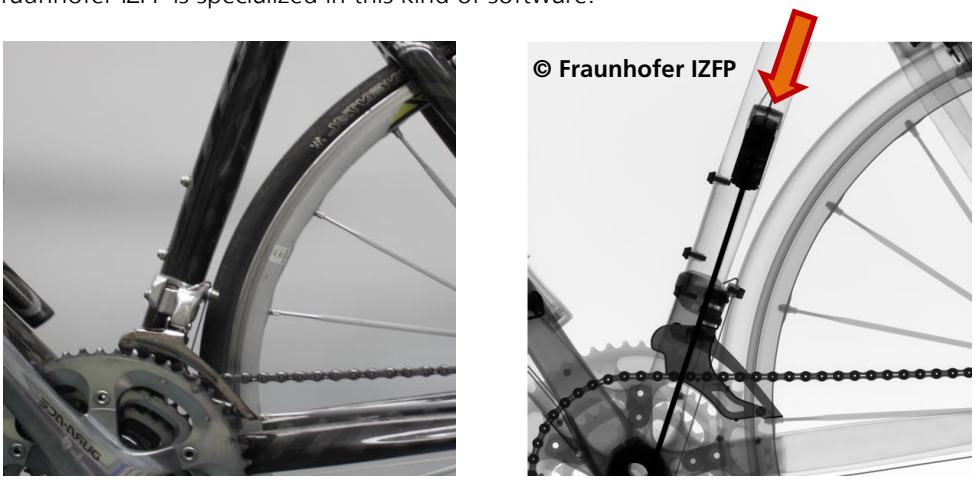

Figure 3:
Image of a CFRP frame ("Carbon frame")
Digital radiography,
Electric motor gear within the frame volume

As a conclusion, we have to notice that beyond the aforementioned conventional measurement techniques Fraunhofer IZFP's top-level research provides many more inspection concepts / techniques driven by intelligently detected and processed signals to uncover information about hidden auxiliary gears in the component volume. The devices in use together with the help of the tailor-made inspection by integrated monitoring systems will guarantee a high-quality, multi-purpose inspection with good efficiency for professional sport.

Fraunhofer IZFP's technology provides tools to demonstrate the correct function and the fair, manipulation-free use of sport equipment not only in the case of cycling but also in further technology-driven professional sports – without need to disassemble the equipment.

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