English transcript of the presentation of „OPTIMUS – Online-Kontrolle von Trinkwasser auf Mikroplastik und andere partikuläre Kontaminanten“ (OPTIMUS – Online monitoring of drinking water for microplastics and other particulate contaminants)

Prof. Bernhard Roth und Dr. Ann-Kathrin Kniggendorf

Ladies and gentlemen, today, I would like to open your eyes to the invisible. You can't see the particles, you can't taste them, but they are there - in your food, in your drinking water, everywhere. I'm talking about microplastics. Yes, we eat plastic. We drink plastic. And all the pollutants on it and in it as well.

My name is Ann-Kathrin Kniggendorf. I have a PhD in physics and work at the Hannover Center for Optical Technologies at the Leibniz University of Hannover. Together with our managing director Prof. Bernhard Roth, I am researching technologies to make microplastics visible in drinking water. The reliable detection of microplastics is required to efficiently remove microplastics so that our food and water are once again free of these artificial particles. Our business partners bbe moldaenke GmbH (Schwentinental), and 4H-JENA engineering GmbH (Jena) support our research project. Today I would like to present to you our research project OPTIMUS. We developed a system to monitor online microplastics and other particulate contaminants in drinking water.

Slide 2: Microplastics in drinking water

Microplastic itself is an umbrella term for particles made of a wide variety of plastics. The only thing that these particles have in common is that they are less than five millimetres in size. The danger posed by microplastics arises from the fact that most plastics are contaminated with pollutants from the manufacturing process and the environment and that they provide ideal surfaces for the growth of bacteria and germs. And these particles have been found in almost all of our foods.

Slide 3: Constant water purification is not the answer

In addition, microplastics are distributed very unevenly in the water. While the tap water is clean in the morning, it can be heavily contaminated at noon. While later, in the evening, there might be hardly any particles found again. This uneven distribution often causes severe contamination in parts of the produced food, that - if at all - is only found afterwards in the final product.

In addition, drinking water contains many dissolved and particulate substances that are crucial for the taste of the water and the products made from it. The purification procedures would remove them along with the microplastics. So cleaning "on spec" is a cost issue and negatively affects the achievable quality of the final product. For this reason, we should monitor drinking water for microplastics and only discard only contaminated water.

Slide 4: Current methods for microplastic detection in water

Drinking water monitoring for microplastics is currently done by filtering the water and examining the particles left on the filter. This process usually involves one of two methods: Raman spectroscopy or its related infrared spectroscopy. Unfortunately, both methods require hours to scan one square millimetre of the filter surface. Therefore, only a few percentage points of the filter's surface are examined, and the result is extrapolated to the entire filter. Thus, we obtain only an approximation of the actual contamination.

Slide 5: ... are not satisfactory.

Even more, the filters have to removed from the apparatus and prepared for the examination. The examination requires expensive clean air conditions. Subsequent contamination with other microplastics is almost inevitable - and a significant source of error, especially in drinking water testing.

Filter-based methods are therefore not suitable for examining the water network for microplastic sources. They only allow a very coarse time resolution in the interval between filter changes. In addition, a reliable result about contamination is always available only after the analysis in the laboratory, i.e., several hours after the occurrence of the contamination. Thus, an online control in real-time is not possible.

Slide 6: The OPTIMUS approach: detection directly in flowing water

OPTIMUS solves the problem because it does not require filters or sampling at all. Instead, we measure directly in the flowing water.

Slide 7: How OPTIMUS works

The practical implementation is straightforward. First, the Optimus system is connected directly to the water tap or, in food operations, to the sampling nozzle of the drinking water supply. The user must then flush it for one hour to remove any foreign microplastics that entered during setup. After that, a laser barrier continuously monitors the water flowing through the measuring chamber. Next, a camera counts all the particles that pass through the laser barrier. At the same time, a spectrometer records the Raman spectrum of the particles. Because a Raman spectrum is as unique as a fingerprint, the measurement chamber can identify the microplastics among the particles.

As the particles pass through the measurement system, they are time-stamped. Thus, in a later step, the particle size and shape of the identified microplastic can be accurately determined using volume microscopy. In addition, particles can be discharged with pinpoint accuracy when subsequent laboratory testing is required.

Slide 8: OPTIMUS measures the following parameters

The Optimus system continuously detects all particles larger than 50 micrometres. It then identifies the microplastic particles among them and determines the plastic from which the particle is made. Optional add-on components enable precise determination of the size and shape of the microplastic. It is also possible to catch and collect detected particles.

This procedure provides all the information needed to track down the cause of microplastic contamination and prevent further contamination. All these parameters can trigger an alarm function. If a specifically defined limit is exceeded, the water supply can be interrupted to avoid ongoing contamination of the product.

Slide 9: Demonstrator

The novel Optimus system is currently tested with a demonstrator - shown in the left image. The demonstrator can examine 1 litre of water per hour, detecting microplastic particles of all common types of plastics, except for Teflon. In addition, the experimental unit can monitor both tap water and turbid process water (as shown in the right image). Automatic cleaning of the flow system is performed at adjustable time intervals.

Slide 10: The advantages of OPTIMUS

We achieve real-time monitoring of the drinking water flow with a reaction time of currently 33 milliseconds!

We reduced the response time to contamination from several hours to less than one second!

With the new technology, water and food producers can interrupt the water influx before microplastics contaminate the product. In addition, since the water is not removed from the measuring system for examination, there is also no subsequent contamination by foreign plastics.

The system works with purely optical measuring methods. Therefore, it works without incurring further costs apart from the electricity and the regular cleaning of the measuring chamber, which is necessary in all drinking water systems.

Slide 11: Contact

We are confident that in the future our OPTIMUS system will contribute to clean, plastic-free drinking water. The optical technologies used to detect microplastics are safe and cost-effective to use. We expect that municipalities and food-producing companies alike will use this technology. Currently, we are working on miniaturizing the device and exploring whether the method is also suitable for detecting toxic algae.

I will be delighted if our development receives further attention. With that, I thank you for your attention, and we will be happy to answer any questions you may have.