

With support from



Federal Ministry  
of Food  
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Projektträger Bundesanstalt  
für Landwirtschaft und Ernährung



by decision of the  
German Bundestag

FRAUNHOFER INSTITUTE FOR RELIABILITY AND MICROINTEGRATION IZM

# PRESS RELEASE

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PRESS RELEASE

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## On the trail of bee mortality with energy-autonomous sensors

**Bees not only provide us humans with honey, but thanks to the pollination of herbs, shrubs and trees, they are significantly responsible for the preservation of species. As a result, they generate around 1.6 billion euros for agriculture and food production in Germany<sup>1</sup>. To help honey bees take flight and advance environmental and agricultural monitoring as well as research on bee health, a research project will now equip them with miniaturized, integrated sensor systems.**

Beekeeping is in vogue, and not just in rural communities, but also in the urban environment. In addition to honey-producing colonies, wild bees in particular are a great support for insect pollination services, which are important for agriculture. For this reason, the recent increase in the number of deaths of various species of wild bees<sup>2</sup> has caused a stir in various regions around the world. Considering the wide distribution of bees, their importance to the agricultural economy, and the general level of knowledge about this insect, it is surprising that the causes of bee mortality are still largely unexplored. Exposure to pathogens, as well as environmental toxins that the insects absorb from the air, water, and plants, has so far only been determined for whole bee colonies based on colony dynamics and honey yield. To better understand which environmental factors are critical for colony health, it is necessary to study both whole colony and individual bee development.

For this reason, the goal of the Sens4Bee project is to collect enough data using various RFID-based sensors in hives and on individual animals to be able to analyze bee welfare in relation to environmental events and parameters. For this purpose, the company Micro-Sensys GmbH is developing a sensor system

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<sup>1</sup> <https://orcid.org/id/eprint/32437/>

<sup>2</sup> Hung et al, Proc Biol Sci. 2018 Jan 10; 285(1870): 20172140; doi: 10.1098/rspb.2017.2140

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to detect temperature, humidity, vibration and acoustic signals in the hive. The Helmholtz Centre for Environmental Research – UFZ is processing the collected data and analyzing its significance for the health status of bee colonies.

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In addition, the Fraunhofer Institute for Reliability and Microintegration IZM is working with Micro-Sensys GmbH to develop sensors that combine a new micro battery technology and micro energy harvesting in a single system. These sensors are attached to bees to determine temperature, brightness and flight movement. The collected data is then processed and displayed in an intelligent cloud solution with analysis tools. In order to make the data obtained available for practical management options in beekeeping, another focus of the project is on smart processing, which provides beekeepers with concrete recommendations for action. For applied research, the individually collected animal and hive data will be linked to environmental events to improve, for example, the assessment of environmental chemicals.

Fraunhofer IZM is developing an extremely small lithium battery and a solar module using silicon technology. These are integrated by the company Micro-Sensys GmbH with the smallest sensor transponders and sensor data loggers with RFID interface in a module so small and light that it can be carried by bees on their backs. The total weight is between two and ten milligrams and is applied in an animal-friendly manner directly during the bees' first stage of development by means of a biocompatible adhesive. Experience with the passive RFID chips used to date has shown that electronic components of this size do not affect or alter bee behavior.

Silicon wafer-level technology can produce hundreds of tiny batteries simultaneously on a single substrate. In contrast to previously common button cells with metal housings, the much lighter silicon is used as the housing material. The researchers' goal here is to supply the system with energy from the battery for the duration of the bee's flight. Charging takes place during the flight phase by daylight. In the hive, the battery is charged by infrared light.

Since the start of the project a few months ago, the focus has clearly been on the technical development of an integrative solution for beehives, individual sensor technology and automated evaluation, which will provide beekeepers with an easy-to-use tool. Beyond this practically oriented clientele, it can be assumed that further bee and environmental institutes as well as national and international research associations can be won over.

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In addition to Fraunhofer IZM and Micro-Sensys GmbH, the Helmholtz Centre for Environmental Research – UFZ, the Institute for Bee Research at the Julius Kühn Institute, Heinrich Holtermann KG and the German Beekeepers' Association are involved in the project. The Sens4Bee project is being funded for a period of three years with a volume of 1.1 million euros. Based on a resolution of the German Bundestag, the project is funded by the Federal Ministry of Food and Agriculture (BMEL). The Federal Agency for Agriculture and Food (BLE) holds the project sponsorship within the framework of the program for the promotion of innovation. The project application was submitted within the framework of the BMEL's "Guidelines for the funding of research projects for the protection of bees and other pollinating insects in the agricultural landscape".

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The **Fraunhofer-Gesellschaft**, headquartered in Germany, is the world's leading applied research organization. With its focus on developing key technologies that are vital for the future and enabling the commercial exploitation of this work by business and industry, Fraunhofer plays a central role in the innovation process. As a pioneer and catalyst for groundbreaking developments and scientific excellence, Fraunhofer helps shape society now and in the future. Founded in 1949, the Fraunhofer-Gesellschaft currently operates 75 institutes and research institutions throughout Germany. The majority of the organization's 29,000 employees are qualified scientists and engineers, who work with an annual research budget of 2.8 billion euros. Of this sum, 2.4 billion euros are generated through contract research.

**Fraunhofer IZM:** Invisible - but indispensable: nothing works without highly integrated microelectronics and microsystems technology. The basis for their integration into products is the availability of reliable and cost-effective packaging and interconnection technologies. Fraunhofer IZM, a world leader in the development and reliability assessment of electronic packaging technologies, provides its customers with customized system integration technologies at wafer, chip and board level. Research at Fraunhofer IZM also means making electronics more reliable and providing its customers with reliable information on the durability of the electronics.

**Micro-Sensys GmbH** operates as a successful company in the field of development and production of technically sophisticated RFID system components. Founded in 1991 in Erfurt, Micro-Sensys GmbH developed into the market leader for specialized RFID system solutions based on a broad standard product portfolio in the HF and UHF frequency ranges. With this portfolio, consisting of various RFID transponders, innovative RFID sensor transponders and data loggers as well as smart low-power RFID write/read devices and user-friendly software tools, the high-tech company operates primarily in niche markets worldwide. Through miniaturization and intelligent integration, wireless identification and sensor systems are becoming accelerators and basic elements of the digital world of things. RFID-based solutions are increasingly being used in industrial applications as well as in retail and logistics, but also in medicine and healthcare, as well as in a wide variety of research fields, and serve to increase efficiency and make optimum use of resources.

At the **Helmholtz Center for Environmental Research – UFZ** in Leipzig, Halle and Magdeburg, nearly 1,000 employees have been developing system solutions for today's complex environmentally relevant research questions since 1991. In addition to the effects of climate change on terrestrial and aquatic ecosystems, the focus is on the consequences of chemicals for human health and the biosphere. Thus, in addition to the distribution and metabolization of the chemicals, the effects at the molecular level are also being studied to gain further insight into the modes of action. These are necessary to improve risk provisioning. That is why knowledge creators at the UFZ often work closely with regulatory authorities, as in the case of the Sens4Bee project with the Julius Kühn Institute, so that insights also become management options.

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**Concept of a bee-carried RFID sensor supported by Fraunhofer IZM's  
miniaturized battery to advance bee health research**  
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**Sensor monitoring in beehives for better analysis of environmental  
chemicals and other negative environmental impacts**  
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