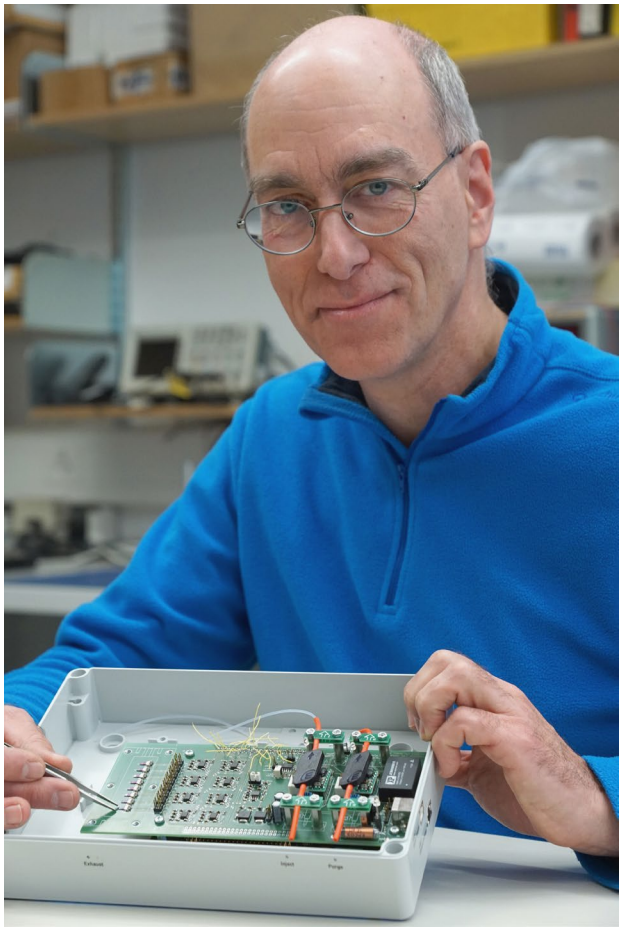
A helping hand enables innovative ideas

Workshops play a valuable role

Since its formation, the SNI has supported the workshops at the University of Basel's Department of Physics. In return, the workshops offer services to the researchers of the SNI network which are often crucial to the execution of novel ideas. In 2016, for instance, the electronics and mechanics workshops were instrumental in refining an electronic nose which the team led by Kavli Laureate Professor Dr. Christoph Gerber has been working on for several years. A research alliance has now been formed to manufacture the device for the first time in small batches for external research groups.



Distortion alters resistance

For some years now, the team led by Christoph Gerber has been developing electronic noses employing minute mechanical sensors that react to trace small amounts of gaseous substances. Each of these microfabricated silicon sensors consists of a round membrane measuring around 1 mm in diameter, held in place within a frame by four tiny beams. The electronic nose developed in Basel combines eight such sensors, with each membrane coated in a different polymer. When a gaseous sample is pumped over the sensors, the molecules in the sample are absorbed into the polymer networks. These networks then swell at different rates and to different degrees depending on the substances present in the sample, resulting in a distortion of the membrane that causes the silicon beams to bend. The beams are fitted with piezoelectric resistors connected to form measurement bridges which convert the distortion into an electrical signal that can be accurately measured by the device's electronic components.

Electronic noses for end users

The team behind the device has already used it to identify specific trace compounds in the exhaled breath of cancer patients which provide clear evidence of the disease with no need for biopsies. In fact, the technology has now matured to the extent that other research groups are interested in acquiring an electronic nose for

their own applications. A project funded mainly by the Nano-Tera program and led by Dr. Hans Peter Lang of Gerber's team now plans to build five of the electronic noses for end users. "However, without the professional support of the workshops at the Department of Physics, this is not possible," remarks Lang. "We need a compact device that unites all the components of the electronic nose. It must meet the requirements of different end user applications without further modifications, be robust, and provide automated data analysis."

Electronics workshop supports development

Andreas Tonin, an engineer in the electronics workshop at the Department of Physics in Basel, was tasked with creating all of the electronics for the new, more compact artificial nose prototype. He designed a circuit board measuring roughly 19 x 9 cm, on which the pumps for the gaseous sample and the purging gas nitrogen, as well as the measurement chamber housing the eight mini-sensors, are arranged. The system electronics designed by Tonin rely on software to reset the measurement bridges before measurement, control the gas pumps and carry out multiple consecutive measurements with each sensor. For each measurement, the electronics amplify the tiny signals emitted by the measurement bridges and use the connected data acquisition card to output the results to the computer, which doubles as a power supply for the system in addition to automatically processing and evaluating the data. The resulting curves are analyzed using multivariate statistical methods, and the data is benchmarked against control compounds. As a result of this procedure, the researchers are able to accurately identify a wide range of gaseous samples.

Wide-ranging cooperation

Besides Andreas Tonin of the electronics workshop, the project also relies on the work of Sascha Martin, head of the mechanics workshop at the Department of Physics. Martin and his team are responsible for supplying the small precision-made measurement chamber housing the sensors, into which the gaseous samples are injected. Another vital contribution is that of Dr. Alexander Bubendorf of Professor Ernst Meyer's group at the Department of Physics, who wrote the software for the project. The project's industry partner is the company Nanoworld AG in Neuchâtel, which supplies the membrane sensors and has a strong interest in optimizing and marketing the electronic nose.

The project is not yet completely finished. For instance, a handbook providing guidance to lay users operating the device and troubleshooting in the event of problems is still missing. "However, our part in the development work is for the most part over, and we are turning our attention to new challenges," reports Andreas Tonin. Christoph Gerber, whose research in recent years has focused entirely on the development of nanomechanical sensors of this sort for medical diagnoses, highlights the excellent cooperation between his team and the workshops: "We are truly fortunate to enjoy such competent and professional support from our workshop technicians. Without their help, many of the successes we have enjoyed in our research would not have been possible."