PRESS RELEASE

Many analytical applications made possible by one flexible IR laser system

Creating new laser systems for use in spectroscopy applications is a challenging and costly endeavor. In order to give even small and medium-sized enterprises access to such innovative technology, the Fraunhofer Institute for Reliability and Microintegration IZM co-launched the QuantumCascade project to develop a modular laser system for a range of multispectral analytics.

Infrared spectroscopy has many uses in a vast range of applications, from geosciences to medical technology or even waste management and recycling. Spectroscopic analytics have become far more precise over the last two decades, and far more complex over the same period. Current devices use light at different wavelengths for a range of multispectral tests, but they have become bulky and stationary. Putting their capabilities into the original handheld form factor would allow sophisticated analytics out in the field, but designing and miniaturizing the technology to do this is a resource and know-how-intensive feat.

This is where the QuantumCascade project enters the picture: A modular and powerful laser system, integrated on a glass board, would bring down the R&D effort needed to develop innovative devices and give makers access to a versatile and reliable light source for spectroscopy. Quantum cascade lasers (QCLs) operate at wavelengths between 2 µm and 15 µm, in the medium infrared (MIR) range. QuantumCascade combines up to three QCLs that can be programmed to emit pulses as short as 5 nanoseconds, which are particularly crucial for spectroscopic analytics with organic substances.

Highly integrated solution for a vast range of applications

Alongside the lasers themselves, the design includes embedded laser drivers that were developed in partnership with Laser Electronics LE GmbH, and integrated optical beamforming using aspherical optics and coupling to special MIR fibers.

The novel design places each QLC inside its own cavity in the glass. The temperature in each can be stabilized separately, which means that the lasers can be operated each at the right temperature and, by implication, the right wavelength. The electronic drivers and control circuits in the design are mounted by industrial soldering processes on a thin-film metallized glass board. Selective laser etching is used to structure this glass board with µm accuracy – so that optical components can be mounted directly. The solution is highly integrated, which makes it possible to encapsulate the entire system – for operation in harsh environments or to get cleaned for use in medical applications.

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When working on the laser system, the researchers could draw on the insights won in the prior PhotMan project's work on a versatile fiber-optical sensor system. QuantumCascade is the next step in the evolution of a thin-glass platform developed at Fraunhofer IZM that integrates and couples optical and electronic components efficiently.

QuantumCascade was a joint project of the Fraunhofer Institute for Reliability and Microintegration IZM and Laser Electronics LE GmbH. The project ran from June 1, 2022 to March 31, 2025, made possible by 390,990 Euros in funding from the Investitionsbank Berlin IBB as part of the Pro FIT project program (project no. 10184209), including funding from the European Regional Development Fund (EFRE).

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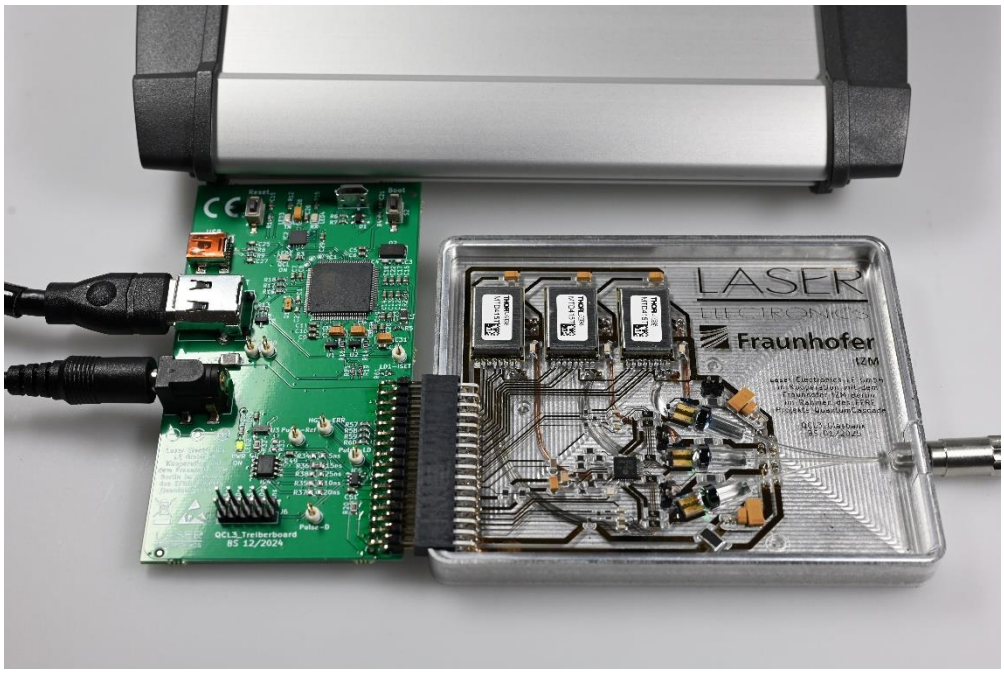

Demonstration unit created in the QuantumCascade project. The thin-glass board developed and constructed at Fraunhofer IZM measures 80 by 100 mm and includes integrated lasers and drivers that can be controlled via a customizable interface. © Gunnar Böttger
Print-quality images: www.izm.fraunhofer.de/pics.

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