

Press Release

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Laser amplifier enables scalable quantum computers and completes European technology chain

Compact and stable laser amplifiers are essential to clear the path towards powerful quantum computing. Working with neQxt GmbH and EOT GmbH, Fraunhofer IZM is laying the groundwork for a reliable and strong European supply chain in this critical area of technology.

Ion trap quantum computers are one of the most promising architectures for error-tolerant quantum computing. But as the number of qubits increases, optical control becomes an increasingly intricate issue. Reliable operation requires lasers that are not only powerful enough but also guarantee exceptional spectral precision and stability. This is where the QAmP project comes in: Amplifier modules for crucial wavelengths (455nm and 493nm) that can be integrated into today's and future quantum computing systems. It tackles one of the bottlenecks throttling current ion-based systems.

Forging a strong European supply chain

Fraunhofer IZM is bringing its substantial expertise in packaging and interconnection technology to bear in the work on a robust integration of electro-optical components. The mission of the institute and its partners is to design amplifier modules that work not just in the lab but are ready to transition into reproducible and eventually automated production. Their work will be tested with an ion trap in a working quantum computer.

This makes QAmP about far more than technological components: The project is laying the technical foundation for scaling future quantum computers. The modules developed here will be validated using an existing quantum computer made by neQxt. A successful test would not only demonstrate technical feasibility but also make a concrete contribution to the industrial availability of this key technology. It will also go a long way towards creating a German supply chain for the key wavelengths, which reinforces Germany's and Europe's technical independence in the area of quantum technologies.

The project is a response to the political call for making Europe's quantum computing efforts more innovative, more resilient in their supply chain, and economically more meaningful. With its involvement in QAmP, Fraunhofer IZM is emphasizing the strategic relevance of microintegration and packaging as enabling technologies for the quantum systems of tomorrow.

For Fraunhofer IZM, QAmP is another example that shows how applied research can help highly complex quantum technology make the leap into meaningful industrial solutions - and contribute substantially to the next generation of European quantum hardware at the same time. The highly integrated design was a particularly crucial feature of the innovation work: The amplifier and the isolator developed for the specific wavelengths required in the project were both integrated into a compact and hermetically sealed glass package at Fraunhofer IZM. Optical fibers help to guide the amplified light to its intended destination.

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Technical Challenges

The developers faced an uphill challenge in their work: The glass package has to be created hermetically sealed to protect the fragile semiconductor laser from the environment. To solve that challenge, Fraunhofer IZM had to come up with a specialized vacuum welding process.

The system also requires intricate thermal management: Metallized contacts going through the glass, called Through-Glass Vias, help dissipate the heat given off by the laser.

Integrating the optical components also forced the researchers to try out new options. Their solution uses an antireflective coated window, directly integrated in the package. Their design also is adhesives-free to avoid the risk of outgassing into the package and instead uses bonding processes that are compatible with vacuum technology.

Alongside Fraunhofer IZM, Electro-Optics Technology GmbH and the quantum technology enterprise neQxt GmbH are involved with the project, supported by the Federal Ministry of Research, Technology and Space as part of the "Enabling Technologies for Resilient R&D Chains in Quantum Technologies" program (funding ID: 13N17477).



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With the laser amplifier validated with an ion trap quantum computer made by neQxt GmbH, QAmP is bolstering Europe's technological sovereignty. © neQxt GmbH | Print quality images: www.izm.fraunhofer.de/pics

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The **Fraunhofer Institute for Reliability and Microintegration IZM** is one of the world's premier research institutions for electronics packaging. With its dedication to developing miniaturized, high-reliability electronics in cutting-edge lab facilities, the institute works to maintain the competitive edge of Germany and Europe.

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