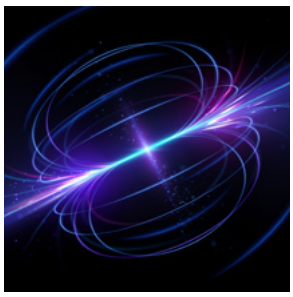
HAMAMATSU
PHOTON IS OUR BUSINESS

Photonics – a key enabling technology in the quantum world

In recent years, the transition of quantum technologies from research labs to industrial applications has been phenomenal. This trend is clearly reflected in public funding, venture capital investments, and patent applications for quantum applications [1]. Broadly, quantum technologies refer to a collection of innovations that exploit quantum phenomena like entanglement, tunneling, and superposition to achieve tangible outcomes beyond limits set by classical systems. A few relatable examples include:

Quantum computers that can solve complex problems faster than present-day supercomputers.

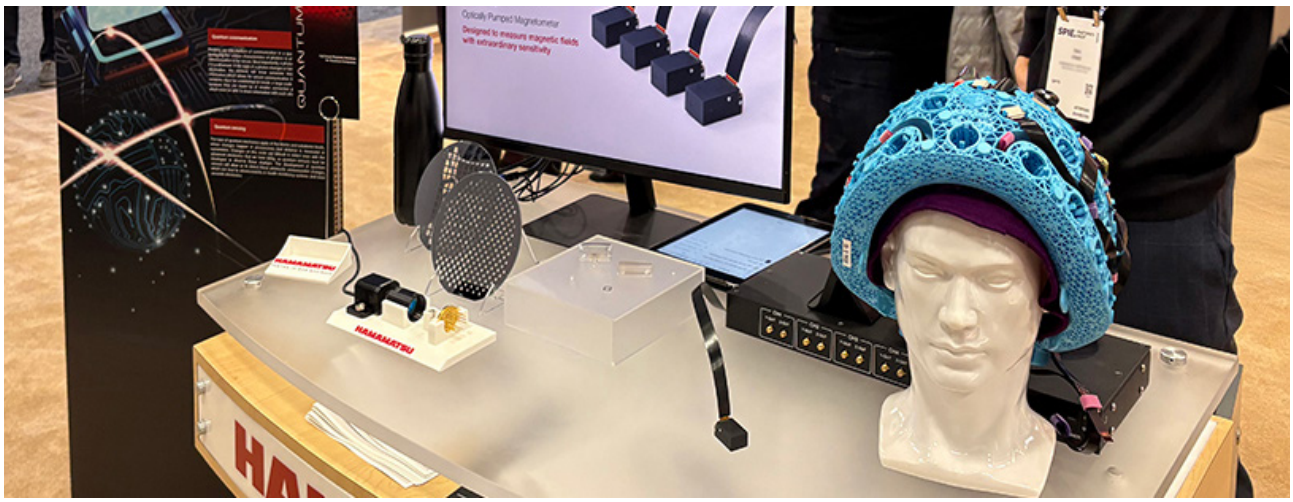
High-precision time measurement for synchronizing communications.



Measurement of minute magnetic fields using sensors that fit in the palm of your hand as opposed to existing ones that occupy an entire room.

Secure communications that are practically immune to interception

Central to all these quantum technologies is a medium that exhibits quantized behavior. In neutral atom computing, this medium consists of a collection of trapped atoms; in ion computing, it comprises trapped ions; and in certain types of atomic clocks, it is a collection of alkali atoms in vapor phase. Photonics technology plays a crucial role in interacting with and manipulating these delicate quantum media while also exhibiting quantized behavior and acting as a reliable carrier of information for networks of quantum devices. In other instances, such as in photonic quantum computing or quantum communications, individual photons themselves act as the quantized medium. In addition, photons can transfer information over long distances with minimal losses compared to electrons and they are unaffected by electromagnetic fields. In essence, photonics is integral to the advancement of several quantum technologies.



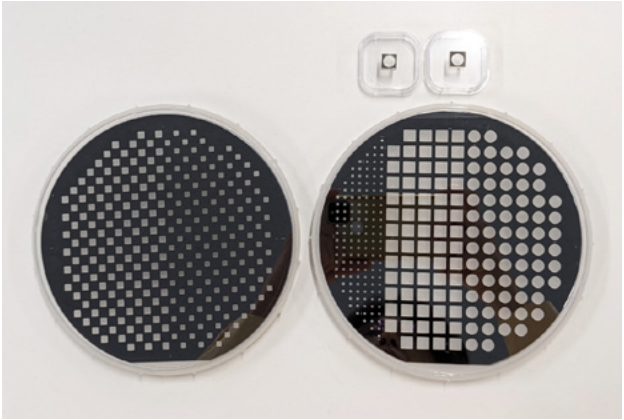
Cerca Magnetics [4] is evaluating OPM for Magnetic Encephalography (MEG). Photo from Hamamatsu Photonics booth at Photonics West 2025.

Hamamatsu Photonics: A Trusted Partner in Quantum Technologies

Since its inception, Hamamatsu Photonics has been a trusted partner of the scientific research community. As a result, the company has developed some of the best photonic technologies available today and continues to lead in this path. At the same time, Hamamatsu is no stranger to the requirements of industrial, medical, and semiconductor applications, which are also key markets. High-volume production and quality control of robust optoelectronic products and systems are an integral part of Hamamatsu's business. With its legacy, expertise, and capabilities, Hamamatsu Photonics is well-positioned to be a photonics partner in the development of quantum technologies.

Vapor Cell Technology: A Key Contribution to Quantum Innovation

One shining example of Hamamatsu's contribution to quantum technologies is its vapor cell technology. In the photonics world, Hamamatsu Photonics is synonymous with photomultiplier tubes (PMTs) which are based on vacuum tube technology. Building on this legacy, the company has developed deep expertise in manufacturing vapor cells of different shapes and sizes, with different coatings, and containing diverse trapped alkali vapors and buffer gases.



Hamamatsu's wafer based vapor cells.

When combined with light sources, detectors, optical elements, and electronics, these vapor cells can be molded into quantum sensors for certain applications. Hamamatsu recently presented its optically pumped magnetometer (OPM) at Photonics West 2025 [2] based on this vapor cell technology. This OPM, packed into a compact volume of less than 8.5 cm3, boasts a magnetic field sensitivity of 20 fT/√Hz, making it suitable for biomedical functional imaging [3].

Hamamatsu is working with Cerca Magnetics [4], a start-up from the University of Nottingham, to commercialize OPM for Magnetic Encephalography (MEG), which noninvasively maps neuronal activity of the brain. The compact size of OPMs allows them to be assembled onto a 3D-printed headset, making MEG measurements more lightweight, portable, and comfortable for patients. OPM revolutionizes MEG measurements when one compares it to the existing MEG machinery that relies on a large, liquid Helium-based magnetic sensor. Hamamatsu's OPM technology will be on dis-

play along with the core vapor cell technology at Hamamatsu's booth at the Laser World of Photonics 2025 in Messe Munich. Hamamatsu is also in the process of developing other types of quantum sensors based on the core vapor cell technology and is open to industrial collaborations.

Beyond Vapor Cells: Hamamatsu's Extensive Quantum Portfolio

Hamamatsu's contributions to quantum technologies extend beyond vapor cell technology. While all of these can be listed here, a few notable innovations can be highlighted:

Liquid Crystal on Silicon Spatial Light Modulators (LCOS SLMs)

These modulators are used to trap large numbers of atoms for neutral atom computing applications. Hamamatsu's LCOS SLMs are known for their low phase jitter, which ensures stable traps, and their high laser power handling capability, which aids in scaling up the power of quantum computers.

High-Speed, Low-Noise Cameras for Qubit Readout

Neutral atom computers require constant monitoring of trap stability and qubit states during operation – both of which are accomplished using high-speed low-noise cameras from Hamamatsu. The latest innovation, qCMOS® technology, has been particularly disruptive in providing a unique combination of precision, speed, and resolution. Whether diagnosing and reading out ion or neutral atom traps or determining the precise number of photons absorbed in a given pixel for a quantum imaging setup, the ORCA® camera series offers the right solution. Recently, Hamamatsu partnered with Quantum Machines to integrate ORCA cameras into their quantum computing hardware [5].

Single-Frequency Lasers for Quantum State Manipulation

Single-frequency lasers are used to manipulate quantum states in neutral atom computers, ion computers, atomic clocks, and other quantum systems. With the acquisition of NKT Photonics, Hamamatsu now offers a range of single-frequency, mode-hop-free, and ultra-stable fiber lasers. The Koheras HARMONIK HP series provides high-power UV & VIS fiber lasers, known for their narrow linewidth light and industrial reliability. They also have a robust design, low noise, and high OSNR and are ideal for quantum computing, sensing, metrology, and communications.

A view from Hamamatsu Photonics' booth at Laser World of Photonics 2023 in Munich, Germany.

Commitment to Quantum Innovation and Collaboration

Hamamatsu's commitment to advancing quantum technologies is evident through these innovations and partnerships. Beyond these examples, the company continues developing cutting-edge photonic solutions tailored for quantum applications.

Our engineers are always keen to discuss these technologies as well as custom solutions through one-to-one interactions. If you would like to explore collaboration opportunities or learn more about our offerings, please reach out to us at info@hamamatsu.eu and drop by our booth at the Laser World of Photonics this June at Messe Munich.

References

[1] McKinsey & Company, The Quantum Technology Monitor 2024s. [Online]. Available: www.mckinsey.com.

[2] SPIE Photonics West 2025 - Quantum West Business Summit: The Path from Startups to End Users in Commercializing Quantum Sensing Technology, SPIE. [Online]. Available: spie.org/photonics-west/event/quantum-west-business-summit-the-path-from-startups-to-end-users-in-commercializing-quantum-sensing-technology/7100481.

[3] S. Zuo et al., "Ultrasensitive Magnetoelectric Sensing System for Pico-Tesla MagnetoMyoGraphy," IEEE Transactions on Biomedical Circuits and Systems, vol. 14, no. 5, pp. 971-984, Oct. 2020, doi: 10.1109/TBCAS.2020.2998290.

[4] Cerca Magnetics, "Homepage," [Online]. Available: www.cercamagnetics.com.

[5] Hamamatsu Photonics, "Quantum Machines and Hamamatsu Photonics Team Up for Enhanced Quantum Computing Control," Apr. 2024. [Online]. Available: www.hamamatsu.com/content/dam/hamamatsu-photonics/sites/documents/21_HPE/press-release/quantum-machines-and-hamamatsu-photonics-team-up-for-enhanced-quantum-computing-control-april-2024.pdf.