

Researchers develop world-leading microwave photonics chip for high-speed signal processing

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The team has developed a world-leading MWP chip capable of performing

ultrafast analog electronic signal processing and computation using optics.
Credit: City University of Hong Kong

A research team led by Professor Wang Cheng from the Department of Electrical Engineering (EE) at City University of Hong Kong (CityUHK) has developed a world-leading microwave photonic chip that is capable of performing ultrafast analog electronic signal processing and computation using optics.

The chip, which is 1,000 times faster and consumes less energy than a traditional electronic processor, has a wide range of applications, covering 5/6G [wireless communication systems](#), high-resolution radar systems, [artificial intelligence](#), computer vision, and image/video processing.

The team's findings were [published](#) in *Nature* in a paper titled "Integrated Lithium Niobate Microwave Photonic Processing Engine." It is a [collaborative research](#) with The Chinese University of Hong Kong (CUHK).

The rapid expansion of wireless networks, the Internet of Things, and cloud-based services has placed significant demands on underlying radio frequency systems. Microwave photonics (MWP) technology, which uses optical components for microwave signal generation, transmission, and manipulation, offers effective solutions to these challenges. However, integrated MWP systems have struggled to simultaneously achieve ultrahigh-speed analog signal processing with chip-scale integration, [high fidelity](#), and low power.

"To address these challenges, our team developed a MWP system that combines ultrafast electro-optic (EO) conversion with low-loss,

multifunctional signal processing on a single integrated chip, which has not been achieved before," explained Professor Wang.

Such performance is enabled by an integrated MWP processing engine based on a thin-film lithium niobate (LN) platform capable of performing multi-purpose processing and computation tasks of analog signals.

"The chip can perform high-speed analog computation with ultrabroad processing bandwidths of 67 GHz and excellent computation accuracies," said Feng Hanke, Ph.D. student of EE and the first author of the paper.

The team has been dedicated to researching the integrated LN photonic platform for several years. In 2018, colleagues at Harvard University and Nokia Bell labs developed the world's first CMOS (complementary metal-oxide semiconductor)-compatible integrated electro-optic modulators on the LN platform, laying the foundation for the current research breakthrough. LN is referred to as the "silicon of photonics" for its importance to photonics, comparable to silicon in microelectronics.

Their work opens up a new research field, i.e., LN microwave photonics, enabling [microwave](#) photonic chips with compact sizes, high signal fidelity, and low latency; it also represents a chip-scale analog electronic processing and computing engine.

More information: Cheng Wang, Integrated lithium niobate microwave photonic processing engine, *Nature* (2024). [DOI: 10.1038/s41586-024-07078-9](https://doi.org/10.1038/s41586-024-07078-9).
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