Move towards 'holy grail' of computing by creation of brain-like photonic microchips

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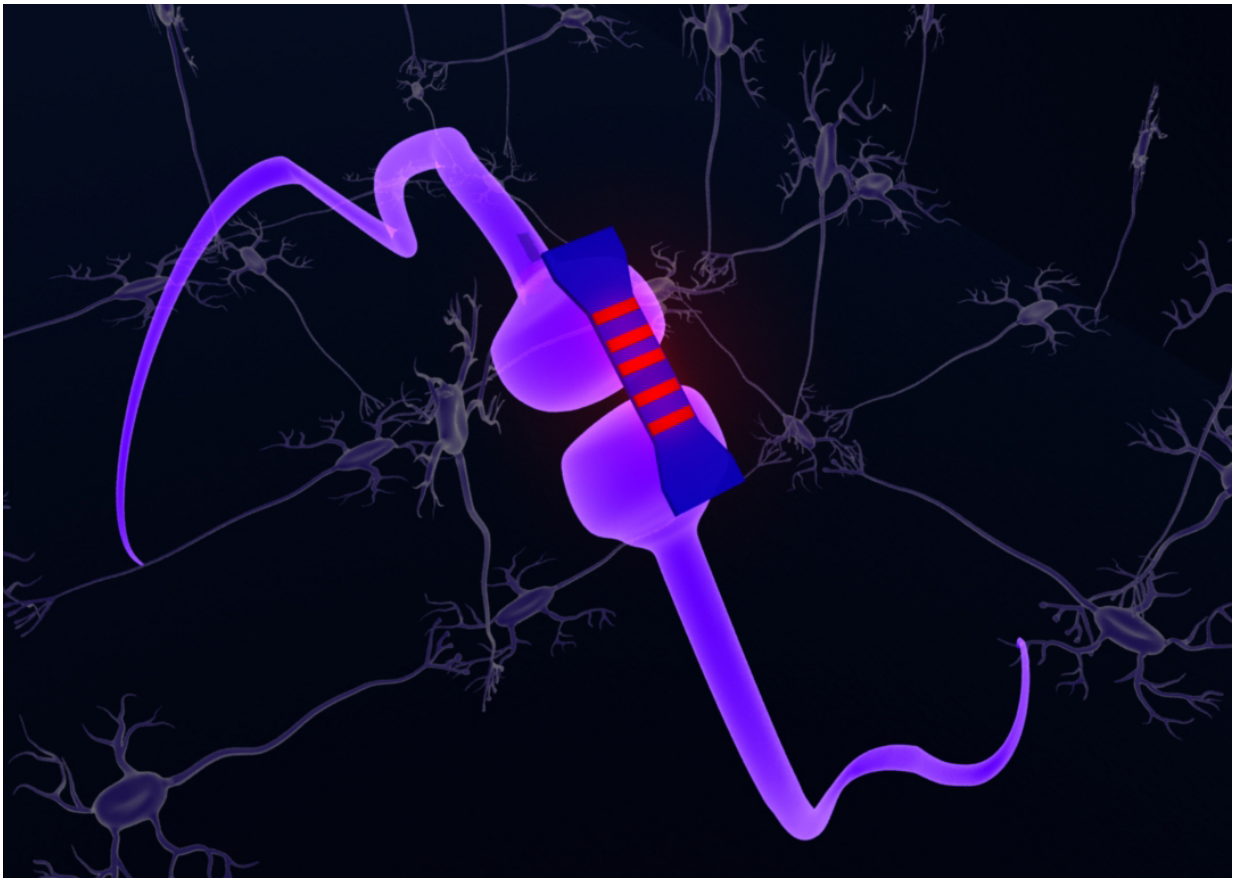


A cartoon image of a photonic synapse in a neuron network. Credit: Harish Bhaskaran

Scientists have made a crucial step towards unlocking the "holy grail" of

computing - microchips that mimic the way the human brain works to store and process information.

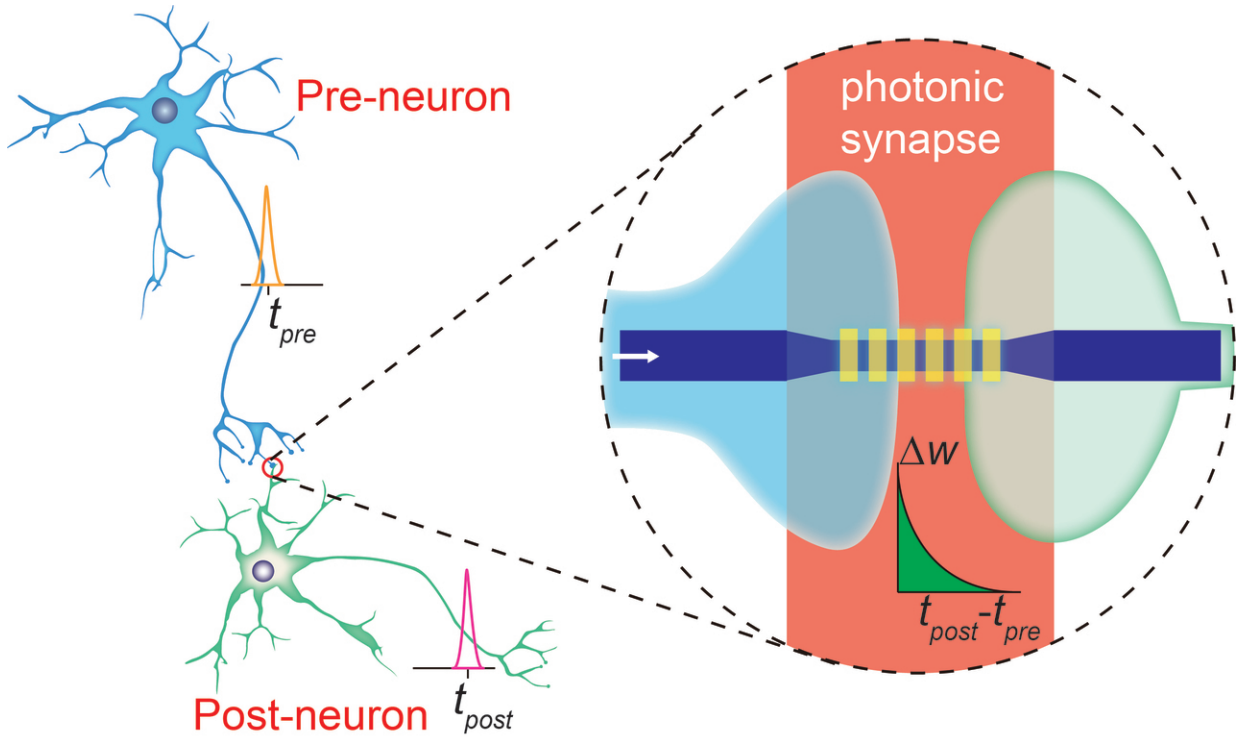
A research team, including Professor C. David Wright from the University of Exeter, have made a pioneering breakthrough by developing photonic computer chips - that use light rather than electricity - that imitate the way the brain's synapses operate.

The work, conducted by researchers from Oxford, Münster and Exeter Universities, combined phase-change materials - commonly found in household items such as re-writable optical discs - with specially designed integrated photonic circuits to deliver a biological-like synaptic response.

Crucially, their photonic synapses can operate at speeds a thousand times faster than those of the human brain. The team believe that the research could pave the way for a new age of computing, where machines work and think in a similar way to the human brain, while at the same time exploiting the speed and power efficiency of photonic systems.

The research is published in *Science Advances* on Wednesday, September 27 2017.

Professor Harish Bhaskaran from Oxford University and who led the team said "The development of computers that work more like the human brain has been a holy grail of scientists for decades. Via a network of neurons and synapses the brain can process and store vast amounts of information simultaneously, using only a few tens of Watts of power. Conventional computers can't come close to this sort of performance."



A schematic of a photonic synapse mimicking the biological synapse connecting neurons. Credit: Harish Bhaskaran

Professor C David Wright, co-author from the University of Exeter, also explained: "Electronic computers are relatively slow, and the faster we make them the more power they consume. Conventional computers are also pretty 'dumb', with none of the in-built learning and parallel processing capabilities of the human brain. We tackle both of these issues here - not only by developing not only new brain-like computer architectures, but also by working in the optical domain to leverage the huge speed and power advantages of the upcoming silicon photonics revolution."

Professor Wolfram Pernice, a co-author of the paper from the University of Münster added: "Since synapses outnumber neurons in the

brain by around 10,000 to 1, any brain-like computer needs to be able to replicate some form of synaptic mimic. That is what we have done here."

'On-chip photonic synapse' by Zengguang Cheng, Carlos Rios, Wolfram Pernice, C David Wright and Harish Bhaskaran is published in *Science Advances*.

More information: "On-chip photonic synapse" *Science Advances* (2017). advances.sciencemag.org/content/3/9/e1700160

Provided by University of Exeter