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Dear Journal of Applied Physics Editors,

At NIST, we are developing neuromorphic hardware based on light for communication and superconducting electronics for computation. We request your consideration of our manuscript entitled “Superconducting Optoelectronic Loop Neurons” for publication in The Journal of Applied Physics.

To put this work in context, we initially proposed superconducting optoelectronic hardware for neuromorphic computing in 2017 (Phys. Rev. App., **7** 0340134 (2017)), but that work left many details of the neural circuits undeveloped. Since then, we have conducted a theoretical analysis of circuits with the desired synaptic and neuronal properties. An initial summary of this theoretical analysis was published in 2018 (J. Appl. Phys. **124** 152130 (2018)). That summary relied on more thorough analysis that was summarized in a series of five papers that were posted on the arXiv but otherwise unpublished. For the work to be complete, transparent, and accessible, we have distilled the key simulations of those five papers in a single document that we now submit to you for your consideration. The paper summarizes the general principles of neural information processing and describes the physical reasoning that leads us to conjecture that superconducting optoelectronic hardware will out-perform all other types of neural systems for large-scale neural computing based on the physics of the hardware. The paper describes the detailed design of receiver circuits operating as synapses in the neural system as well as the circuits which adjust the synaptic weights and implement synaptic plasticity mechanisms. The paper goes on to explain the circuits that generate light during a neuronal firing event and analyzes how these neurons will scale when implemented in large networks. By the end of the analysis, we find the potential to scale these networks up to large, cognitive systems is remarkable. This work goes far beyond our original 2017 paper as well as the 2018 summary and is likely to guide our experiments for years to come.

We think this manuscript presents significant details of an emerging technology that may transform the advanced computing landscape. We are confident in the assertion that this technology will be transformative because we have based the reasoning based on two simple, physical principles: light is ideal for communication in neural systems, and single-photon communication will lead to the highest energy efficiency. The rest of the design choices follow quite naturally from the information-processing principles of neural systems.

We understand that a paper of this length is not common, yet we think the detail and scope of the manuscript is required to support the claims we are making. We think the manuscript “significantly advances understanding in contemporary applied physics”, and therefore meets a key requirement for publication in the Journal of Applied Physics. Extensive experimental work remains to be conducted, and we hope this foundational paper will guide researchers in integrated photonics, superconducting electronics, and computational neuroscience to contribute to the promising field of superconducting optoelectronic networks.

Best regards,

Jeff Shainline