

# Electronic-photonic integrated quantum simulator platform: from algorithms to hardware control

Yong Kwon<sup>1,2</sup>, Leonardo Limongi<sup>1,3</sup>, Martino Bernard<sup>1</sup>, Fabio Acrebi<sup>1</sup>, Gioele Piccoli<sup>1</sup>,  
Byung-Soo Choi<sup>4</sup>, Georg Pucker<sup>1</sup>, Mher Ghulinyan<sup>1</sup>

1. Centre for Sensors and Devices, Fondazione Bruno Kessler (FBK), Trento, Italy

2. Department of Physics, University of Trento, Trento, Italy

3. Department of Industrial Engineering, University of Trento, Trento, Italy

4. Department of Scientific Computing, Pukyong National University (PKNU), Busan, South Korea

**Abstract:** We report on full-stack of an integrated photonic-electronic quantum simulator platform. We demonstrate the platform operated by reconfigurable integrated photonic integrated circuits with fully automated electronic control with software.

We will demonstrate our recent developments of a full-stack of an integrated photonic-electronic quantum simulator platform, covering from concepts on quantum information processing to photonic integrated circuits (PICs). The PICs are based on reconfigurable MZI networks for operation in the near-infrared spectral range (780nm to 820 nm wavelength), while the on-chip detection relays on waveguide-coupled Silicon Single Photon Detectors operating at room temperature [1,2]. The photonic circuitry is realised on FBK’s Silicon Nitride platform [3] and uses more than 90 thermo-optic phase shifters on the MZI networks both in the Reck and Clements schemes. Multiple phase shifters are controlled by customised pulse-width modulation application-specific integrated circuit (PWM ASIC), which can automatically perform phase shifts according to codes from our control driver with a field-programmable gate array. The driver, we developed written in python, allows the gradual electrical initialization of the system (setting all components on READY condition), the desired setting up of the MZI network configuration, and gradual electrical shutdown of the system. The correct functioning of the series of procedures will be necessary to conduct quantum simulation experiments.

Also, to operate the platform as a quantum simulator, we designed and implemented software platform for our linear optical quantum computing device. The software, mainly developed by PKNU and written in python, was tested on our photonic hardware developed in FBK and proved to function perfectly [4]. This software allows not only converting user-written quantum circuits into sets of quantum gates for each qubit but also supports encoding for quantum information processing into MZI-based integrated photonics hardware. Additionally, the software includes the compatibility on universal and scalable computing according to the theoretical concepts of Ref. [5].

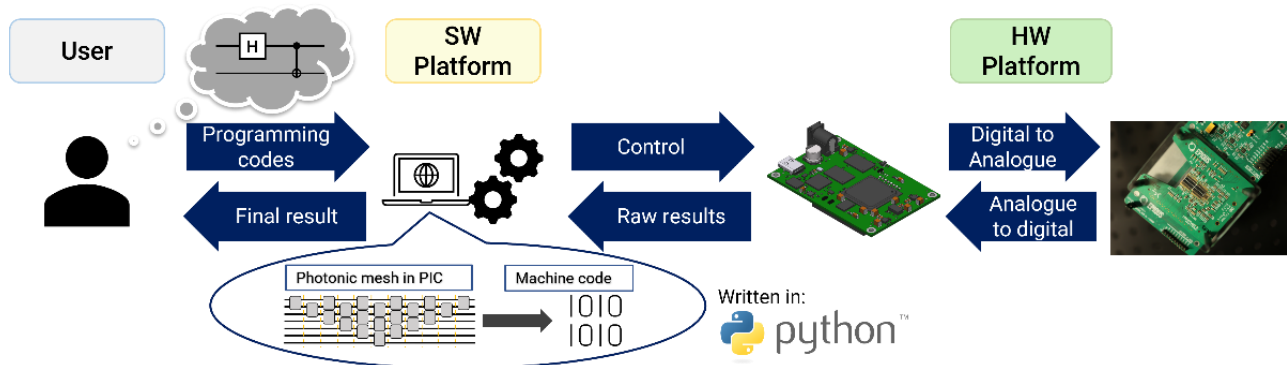


Fig. 1 Full-diagram of an integrated photonic-electronic quantum simulator platform.

We explain our current work on debugging and characterisation of phase shifters in PICs controlled by electronics in our board. We also show an example experiment,  $\pi$ -shift, to clearly demonstrate the ability to controlling the shifters by PWM ASICS using our control driver.

## References

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