As presented in Table I, different types of quantum computers such as superconducting, photonic, annealing, trapped ion, have different characteristics and advantages. Photonic quantum computers provide unique benefits for quantum computing. They use photons as qubits, which are highly resistant to decoherence, allowing for stable operation in noisy environments. Unlike superconducting quantum computers, photonic quantum computers operate at room temperature, which reduces both operational complexity and costs. Additionally, photonic quantum systems offer inherent parallelism and high-speed data processing capabilities due to the properties of photon. These advantages make photonic quantum computers more highly scalable, stable and efficient for various quantum computing applications.

TABLE I

ADVANTAGES OF DIFFERENT QUANTUM COMPUTERS WITH MAINSTREAM PROVIDERS

| Quantum computer types | Provider (Qubits) | Advantages |
|---|---|---|
| Superconducting | IBM (433)、Google (72)、OriginQ (24) | Universal quantum computer; high speed. |
| Photonic | USTC (255)、QBosoN (500+) | Operates at normal temperature; Long coherence time; |
| Annealing | D-wave (5000+) | Large-scale qubits |
| Trapped Ion | IonQ (32) | Stable operation; High fidelity of quantum gates |

**For real coherent photonic quantum computer *CPQC-1***

Overview of the photonic quantum computer is shown in the right side of Fig. 1. The coherent Ising machine (CIM) developed by Quantum Boson (QBosoN) is an advanced photonic quantum computer with distinct advantages in room-temperature photonic quantum encoding control and full connectivity.

This hybrid quantum computing system integrates both photonic and electrical subsystems. The photonic subsystem handles the preparation and storage of qubits through components such as femtosecond fiber pulsed lasers, erbium-doped fiber amplifiers (EDFA), and periodically poled lithium niobate (PPLN) crystals, which together generate photonic pulses (also called "photonic qubits") with specific phase and amplitude in a fiber loop. The electrical subsystem comprises balanced homodyne detection (BHD), field-programmable gate arrays (FPGA), intensity modulators (IM), and phase modulators (PM). This subsystem measures the photonic pulse amplitudes, computes feedback signals based on the Ising problem matrix, and modulates the feedback pulses to guide the photonic qubits towards the lowest Hamiltonian state. This process effectively solves the Ising problem by mapping binary variables $x_i \in \{0,1\}$ to spin variables $\zeta_i \in \{-1,+1\}$ and minimizing the energy function. Unlike classical computers that rely on semiconductor integrated circuits, the CIM-based photonic quantum computer employs photonic pulses for quantum computation. In its degenerate photonic parametric oscillator, pump light interacting with a nonlinear photonic crystal produces coherent light with phases corresponding to spin states, which are used to solve optimization problems. By leveraging these principles, CIM-based photonic quantum computers can address QUBO problems by mapping them to Ising models, with the CIM minimizing the Hamiltonian to find the solution.

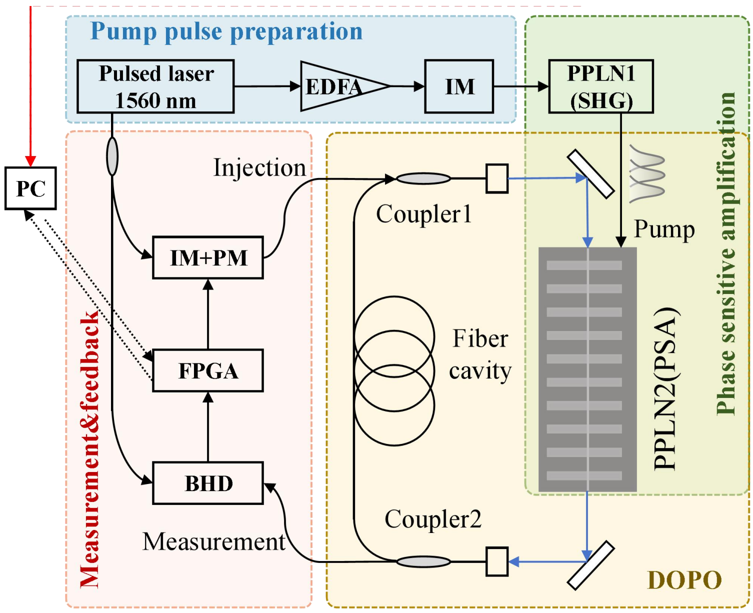


Fig. 1. The schematic diagram of the CPQC-1 quantum computer