

## Software architecture for cold-atoms quantum computer

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We present an original software architecture with QUIL-based [1] quantum instruction language for the cold-atoms quantum computer, currently developed in Lomonosov MSU Quantum Technologies Centre. Compared to QUIL specifications, this architecture is simplified for purposes of native execution on quantum hardware. It provides only the lowest-level hardware-implemented quantum gates and classical instructions to work with word-addressable classic memory, which allows programming on the assembly level. The language syntax mostly follows QUIL specifications, except that arbitrary gate specification is not permitted, and circuit definitions or any other function-like expressions are not supported yet. Classical gates are presented by basic arithmetical operators, memory management, and general flow-control directives like HALT that stops the running program or JUMP that allows program execution from arbitrary address. Quantum gates are represented by management commands like INIT that initializes a quantum register of a given size, arbitrary one-qubit rotations, native entangling operator CZ, and MEASURE gate. This language was created to work with basic quantum computer functionality, and we plan to develop the OpenQASM compiler in the future.

QUIL specifications are general and leave freedom for a particular implementation. Besides, some additional information should be provided for a successful build of the quantum program into an ELF executable file. Therefore, now we have our specifications of quantum instruction language, compiler, and API for interacting with a remote quantum computer, written both in Python and C++.

## References

- [1] *Robert S. Smith, Michael J. Curtis, William J. Zeng*, A Practical Quantum Instruction Set Architecture, Rigetti Computing, [arxiv.org/abs/1608.03355](https://arxiv.org/abs/1608.03355) (2017).