Dear Selection Committee,

It is a great pleasure for me to write this letter of reference for Evgeny Safronov with regard to his application to the Skolkovo Institute of Science and Technology. I've known Evgeny since Autumn, 2016 when he showed interest in joining the group of Prof. Alexey Ustinov at Russian Quantum Center where I am responsible for recruiting students. Evgeny had been already recommended to me by Prof. Valery Ryazanov as a knowledgeable and hard-working student before I have interviewed him. Besides ascertaining these statements during the interview, I was also able to establish Evgeny's outstanding programming skills and willingness to engage into solving challenging problems. He displayed himself as a communicative and an open-minded person as well. These qualities have convinced me that Evgeny would fit in our group and make valuable contributions to our work. I have recommended Evgeny to be accepted to our laboratory and have been assigned to be his unofficial supervisor.

After the year of Evgeny's Bachelor studies, I am not in a single way disappointed with my decision. During this time, Evgeny has proven himself as a student with a solid background, capable of applying his skills and knowledge to new problems that he faces. He has demonstrated the ability to do research on his own and to churn out interesting ideas based on his work, which is rare. Next, I would like to highlight again the aptitude Evgeny has for programming and numerical modelling which has played a great role in the successful completion of his tasks. Finally, I had a chance to get to know Evgeny in person during our work together, and I find him as a sociable and easy-going person who can easily integrate into a new community.

From the beginning, Evgeny was willing to work with numerical modelling of quantum circuits. This is a complex area, requiring strong knowledge of quantum mechanics and ability to write clean and bug-free code. He was able to quickly master the Python library called QuTiP (Quantum Toolbox in Python) by using it to obtain solutions for several standard problems from the domain, e.g., transmon-qubit dynamics under coherent driving. Some of the methods he used during his work are original and are of value for our future work. Notably, Evgeny has learned from literature and other sources that he found on his own when he needed it.

Having mastered the basic methods of modelling quantum systems, Evgeny started to work in two directions. First direction was to analyse different ways of performing two-qubit gates, compare them and to expose their strengths and weaknesses. Second direction was to model single-qubit gates performed with the real-world multilevel systems to reveal the errors that emerge from this and to find optimal ways to apply the control microwave radiation to reduce them.

Solving the first task, Evgeny has, firstly, successfully simulated fast detuning of the transmon frequency with magnetic flux and performed CPHASE and iSWAP-like two-qubit gates using this technique, and, secondly, modelled the cross-resonance gate for two strictly two-level systems. I want to note the decent amount of reading and analysing that Evgeny has done to develop his models and verify the results. In the end, some subtle problems with each type of gate were revealed. This will be very helpful in planning our future experiments.

The second task allowed Evgeny to fully demonstrate his programming skills. He developed an object-oriented library on top of the QuTiP package which allows user to quickly simulate any kinds of pulses applied to arbitrary quantum systems. That required tremendous amount of work and debugging, as well as the ability to develop a flexible architecture to incorporate all possible cases. Using this library, Evgeny has successfully analysed the phase errors observed in the computational basis in multilevel systems and ways to cope with them (DRAG, HD, GRAPE). GRAPE is a method of particular value, as long as Evgeny applied an original modification of it to be able to simulate non-RWA pulses in multilevel systems.

To sum up, Evgeny has proven himself not only as a passionate young scientist with a strong background in physics and advanced skills in computer science, but also as an assiduous and eager worker. His communication and teamwork skills are of no doubt, as well. This allows me to rank him among top 5% of the students I have known, including the Master's students. Despite I was not able to assess Evgeny's experimental abilities due to the lack of time, from what he told and shown me concerning his activities connected with robotics,

I believe that he would be successful in the experimental work, as well. Finally, even though I hope that Evgeny will continue his work in our group, I think he would be an outstanding asset to the Master's program at Space System Center at Skoltech.

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