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Fighting readout noise
in IBM quantum devices

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We are entering an era in human history, when there are emerging new technologies which rely on quantum phenomena like quantum superposition and entanglement. Example of such devices are superconducting transmon qubits [1], which are one of the most promising candidates for realizing scalable quantum computers. Prototypes of chips of superconducting qubits have recently became publicly available via the cloud service created by IBM [2]. However, since the quantum computing technology is still in its infancy, the devices themselves are currently noisy and imperfect. Specifically, IBM chips suffer from different kinds of errors in state-preparation, execution of quantum gates and performing quantum measurements (readout of qubits).

The main aim of this talk is to present a simple scheme of correction of readout-errors by classically post-processing the experimental results (which means simply some „standard" computer operations made on the experimental data). The method is based on performing Quantum Detector Tomography of the device and works well for specific kind of readout noise, which is shown to be the dominant form of readout noise in IBM devices.

In the talk I will briefly describe the notion of generalized quantum measurements (POVMs [3]) and how to use them to model imperfect implementation of the ideal (projective) measurements. Then I will introduce the idea of Quantum Detector Tomography and explain how it can be used to construct error mitigation strategies for the readout errors. Finally, I will present experimental results showing what kind of readout errors occurs in IBM quantum devices and to what extent our correction scheme is able to correct for them. Lastly, I will present results of implementation of our error mitigation strategy to improve the performance of IBM chips for exemplary quantum information tasks.

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[3] A. Peres, Quantum theory: Concepts and methods, Vol. 57 (Springer Science & Business Media, 2006).

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