EPJ Web of Conferences **103**, 01008 (2015)
DOI: 10.1051/epjconf/201510301008

Experimental Adaptive Bayesian Tomography

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We discuss an experimental realization of an adaptive quantum state tomography protocol. The method we suggested and tested takes advantage of a Bayesian approach to statistical inference and is naturally tailored for adaptive strategies. For pure states we observe close to $1/N$ scaling of infidelity with overall number of registered events N, while best non-adaptive protocols allow for $1/\sqrt{N}$ scaling only. This is the theoretical limit for any tomographic protocol, and further improvement may only affect pre-factors in this power law. Also we consider particular strategies of the state reconstruction based on adequate and inadequate models and compare their scaling.

Experiments have been performed for polarization qubits and ququarts, but the approach is readily adapted to any dimension. Our method does not take into account systematic errors caused, for example, by inaccuracies in retardant plates rotation. However for the reached values of infidelities of on the order of 10^{-4} – 10^{-3} we did not observe any deviations from expected behavior and were not able to identify the influence of systematic errors.

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Article available at http://www.epj-conferences.org or http://dx.doi.org/10.1051/epjconf/201510301008