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360-degree quantum tomography of a qudit CHARLES BALDWIN, AMIR KALEV, UNM, HECTOR MARTINEZ, NATHAN LYSNE, POUL JESSEN, UoA, IVAN DEUTSCH, UNM — Quantum information processing consists of three components each with a respective tomography technique: preparation/state, evolution/process, and measurement/detector. Previous works have diagnosed a single component individually yielding an estimated density matrix, process-matrix, or POVM, which is compared to a corresponding target. However, all three types of tomography are interrelated, and accounting for only one implies that the estimator produced suffers from systematic errors. Other techniques exist to quantify the average error rates of a single part, e.g. randomized benchmarking, but fail to give information on the type of error. One goal of quantum tomography is to produce a reliable estimate to diagnose sources of errors. To study this we model a cold-atom testbed–the coupled electron-nuclear spins of the 16-dimensional ground manifold of Cs, initialized by optical pumping, controlled by magnetic and optical fields, and measured by Stern-Gerlach analysis. In a complete 360-degree cycle we can use known states as leverage to correct errors in POVMs, and in turn correct errors in processes, which allows us to improve state preparation, etc. This protocol allows us to produce reliable estimates while diagnosing sources of errors that one can work to correct.

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