Abstract Submitted
for the DAMOP18 Meeting of
The American Physical Society

High signal, low background detection of a single trapped neutral atom[1] MARGARET E. SHEA, JAMES A. JOSEPH, PAUL M. BAKER, JUNGSANG KIM, Duke University, DANIEL J. GAUTHIER, The Ohio State University — Single neutral atom trapping provides a promising platform for the study of fundamental physics and quantum information protocols. Detecting single neutral atoms is critical for the utility of these traps. Here we report on a high signal, low background detection system for a far-off-resonant trap (FORT) containing a single ^{87}Rb atom. The system consists of an off-the-shelf in-vacuum lens and single-photon-counting avalanche photodiode. An EMCCD camera is used for initial alignment and imaging. We use a probe/cool detection scheme that is insensitive to the atomic ground state. Through careful optimization of the scheme frequencies and polarization, we are able to collect $\geq$50,000 counts per second emitted primarily on the $F = 2 \rightarrow F' = 3$ transition. We achieve signal-to-background ratios in excess of 25. The detection scheme is non-destructive and the atom can survive in the FORT for multiple detections. We show how the results scale with detect-beam frequency, power, polarization, and duration. This scheme sets the stage for high fidelity, nondestructive quantum state detection.

[1]We gratefully acknowledge the financial support of the ARO through Grant # W911NF1520047.

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Date submitted: 26 Jan 2018 Electronic form version 1.4