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Optical storage with electromagnetically induced transparency in cold atoms at a high optical depth[1] SHANCHAO ZHANG, SHUYU ZHOU, CHANG LIU, J.F. CHEN, Department of Physics, The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, China, JIAN-MING WEN, Department of Physics and National Laboratory of Solid State Microstructures, Nanjing University, Nanjing, Jiangsu, China, M.M.T. LOY, G.K.L. WONG, SHENGWANG DU, Department of Physics, The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, China — We report experimental demonstration of efficient optical storage with electromagnetically induced transparency (EIT) in a dense cold ^{85}Rb atomic ensemble trapped in a two-dimensional magneto-optical trap. By varying the optical depth (OD) from 0 to 140, we observe that the optimal storage efficiency for coherent optical pulses has a saturation value of 50% as OD $>$ 50. Our result is consistent with that obtained from hot vapor cell experiments which suggest that a four-wave mixing nonlinear process degrades the EIT storage coherence and efficiency. We apply this EIT quantum memory for narrow-band single photons with controllable waveforms, and obtain an optimal storage efficiency of 49$\pm$3% for single-photon wave packets. This is the highest single-photon storage efficiency reported up to today and brings the EIT atomic quantum memory close to practical application because an efficiency of above 50% is necessary to operate the memory within non-cloning regime and beat the classical limit.

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