Abstract Submitted
for the DAMOP10 Meeting of
The American Physical Society

Tailored State Preparation for Solid-State Quantum Memory JINGYUN FAN, ELIZABETH GOLDSCHMIDT, SERGEY POLYAKOV, Joint Quantum Institute, SARAH BEAVAN, Australia National University, ALAN MIGDALL, Joint Quantum Institute — Rare earth ion-doped crystals are promising candidates for ensemble-based quantum memory because they are solid-state systems with narrow optical transitions and seconds-scale coherence times. We are using one such material, Pr3+:YSO, to generate single photons and implement a quantum memory protocol. A major challenge associated with rare earth ion-doped crystals is the large inhomogeneous broadening of the optical transition. We report experimental progress using spectral hole-burning techniques to create a narrow absorbing feature on a background emptied of absorbers that acts as an inhomogeneously narrow ensemble for quantum memory applications. We also describe a narrow spectral filter generated via spectral hole-burning that can separate fields a few MHz apart with 15 dB extinction. This filter is necessary due to the few MHz splitting of the hyperfine ground states that we use for the quantum memory. Finally, we develop a model of spectral hole-burning in rare earth ion-doped crystals and use it to perform a computational optimization of our state preparation scheme. We find that the optimal parameters of our spectral hole-burning sequence are experimentally accessible and flexible.

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Date submitted: 16 Mar 2010 Electronic form version 1.4