Nanophotonic photon echo memory based on rare-earth-doped crystals TIAN ZHONG, JONATHAN KINDEM, EVAN MIYAZONO, ANDREI FARAON, Caltech, CALTECH NANO QUANTUM OPTICS TEAM — Rare earth ions (REIs) are promising candidates for implementing solid-state quantum memories and quantum repeater devices. Their high spectral stability and long coherence times make REIs a good choice for integration in an on-chip quantum nano-photonic platform. We report the coupling of the 883 nm transition of Neodymium (Nd) to a Yttrium orthosilicate (YSO) photonic crystal nano-beam resonator, achieving Purcell enhanced spontaneous emission by 21 times and increased optical absorption. Photon echoes were observed in nano-beams of different doping concentrations, yielding optical coherence times $T_2$ up to 80 $\mu$s that are comparable to unprocessed bulk samples. This indicates the remarkable coherence properties of Nd are preserved during nanofabrication, therefore opening the possibility of efficient on-chip optical quantum memories. The nano-resonator with mode volume of $1.6(\lambda/n)^3$ was fabricated using focused ion beam, and a quality factor of 3200 was measured. Purcell enhanced absorption of 80% by an ensemble of $\sim 1 \times 10^6$ ions in the resonator was measured, which fulfills the cavity impedance matching condition that is necessary to achieve quantum storage of photons with unity efficiency.