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Frequency stabilization of a silicon magneto-optical trap repump laser JONATHAN GILBERT, SAMUEL RONALD, SIU AU LEE, WILLIAM FAIRBANK, Colorado State Univ — The primary goal of this research is to trap a single silicon atom in a magneto-optical trap. The trapped atom can be photoionized and used as a deterministic ion source. This allows for the possibility of precise implantation of a single Si^+ ion into a suitable substrate, leading to a scalable production process for solid-state quantum computers. Silicon has a $^3P_2$-$^3D_3{}^o$ cooling transition at 221.7 nm with a weak branching transition to the $^1D_2$ metastable state. To close the cooling cycle it is necessary to excite the atom from the metastable state back to the $^3D_3{}^o$ level using a 256.26 nm repump laser. This wavelength is generated through frequency quadrupling an external cavity diode laser. Since the repump transition wavelength has not been measured accurately, but is calculated from measurements of other stronger transitions, it will be necessary to scan this laser over the range of uncertainty. Frequency stabilization of the repump laser over a tuning range is achieved by locking the second harmonic beam at 512 nm to an $^{129}I_2$ hyperfine peak using an acousto-optic modulator to provide the frequency offset and modulation. The absolute frequency of various $^{129}I_2$ peaks in the region of interest were calibrated by comparing to $^{127}I_2$ spectra obtained through saturated absorption spectroscopy, using a 75 MHz free spectral range interferometer as a reference scale.

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