0.0.1 Development of an tunable external-cavity narrowed diode laser for optically pumping ^{3}He

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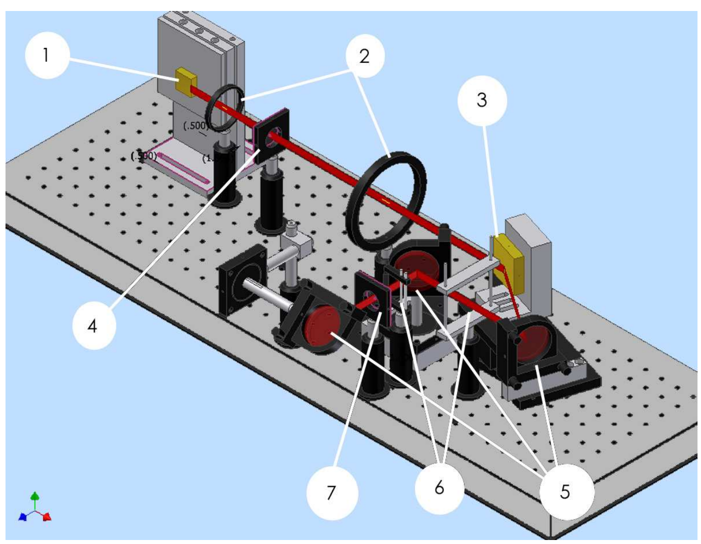
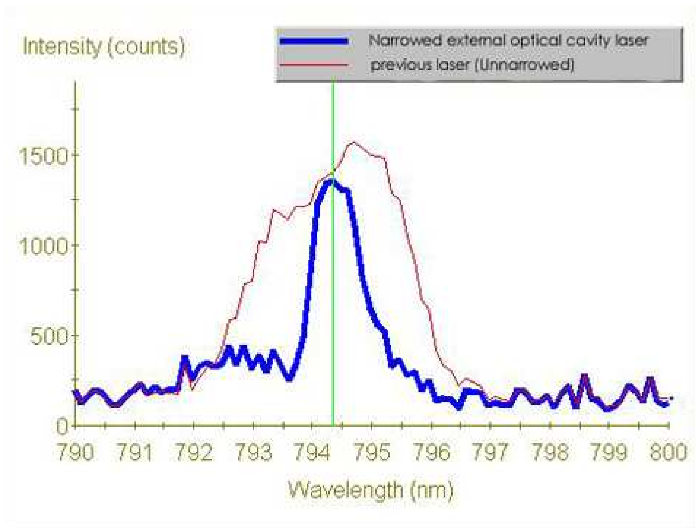
Achieving high spin-polarizations of ^{3}He is important for many experiments at TUNL and the FEL. To accomplish this, a laser tuned to 795 nm and circularly polarized is shined onto a mixture of Rb vapor ^{3}He and N_2, and kept at a controlled temperature of around 190^o C within a highly uniform magnetic field of about 0.7 mT, aligned with the direction of propagation of the laser light. The circularly polarized light at 795 nm spin polarizes the Rb atoms which in turn exchange their spin with the ^{3}He nuclei. A small amount of N_2 is present to quench the re-emission of photons by the Rb.

Until now we have used an array of laser diodes that are coupled to optical fibers, fed into a beam splitter, then circularly polarized and focused onto the pumping cell. Others [IAN00] have demonstrated that higher polarizations have been achieved if the linewidth of the light is narrowed by use of an external optical cavity. Laser diodes used in this way give the narrowness of a traditional laser at the reduced size and cost of a diode laser. An external cavity diode laser system such as ours has the advantage of being lightweight, portable and wavelength-tunable, besides giving a more narrow linewidth, making it relatively easy to move between testing and experimentation. The external cavity system as shown below consists of (1) a small 50 W Quintessence diode laser, (2) a 4X telescope to enhance feedback, (3) a Littrow mounted [Zor95] mirrored grating as the output and feedback mechanism, (4) a $\frac{1}{2}$ wave plate to control the amount of feedback, (5) mirrors to direct the beam, (6) cylindrical lenses to shape the beam, and (7) a $\frac{1}{4}$ wave plate to circularly polarize the light.



We have not been able to make enough tests to draw firm conclusions about our narrowed laser system as compared to our previously non-narrowed laser. With the aid of a spectrometer, we see that our laser does become more narrow relative to its own unnarrowed output, and also that it is more narrow than our previous laser.



The unnarrowed laser is represented by the thin line and the narrowed laser is represented by the thick line. The peak of the narrowed laser was tuned by observing the absorbtion of the old laser by the Rb. The linewidth of 1 nm FWHM is characteristic of the limits of the resolution of our spectrometer, and not necessarily the actual width of the line of our narrowed laser.

[IAN00] B. Chann I. A. Nelson and T. G. Walker. *Spin-exchange optical pumping using a frequency-narrowed high power laser diode.* App. Phys. Lett., **76**(2000) 1357–8.

[Zor95] P. Zorabedian. In *Tunable Lasers Handbook, edited by F. J. Duarte*, page 349, 1995.