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An injection-locked Titanium:Sapphire laser system for a high-resolution resonance ionization spectroscopy.

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Hyperfine structures and isotope shifts in electronic transitions contain readily available model-free information on the single-particle and bulk properties of exotic nuclei, namely the nuclear spin, magnetic dipole and electric quadrupole moments as well as changes in root-mean-square charge radii [1]. Recently, resonance ionization spectroscopy (RIS) in a low-temperature supersonic gas jet utilizing a narrowband first step excitation [2] has been demonstrated to be a powerful tool for probing exotic nuclei [3]. An optimal solution to combine high pulse powers, required for efficient RIS, with a narrow bandwidth is the pulsed amplification of a narrow-band continuous wave (CW) laser. In a regenerative Titanium:Sapphire amplifier, the cavity length is locked to a multiple of the seed wavelength allowing lasers to reach a final output power of several kW (during the pulse) from the few mW of CW input.

We present a pulsed injection-locked Titanium:Sapphire laser [5] designed with an emphasis on stability and reproducibility. The laser design couples low vibration sensitivity with stability via FEM simulation optimized feet positions and by integrating the injection and cavity optic mounts onto the baseplate. In addition, the laser can be configured for different cavity round-trip lengths and intra-cavity second harmonic generation. The laser has been commissioned in the PALIS laser laboratory [4] in the RIKEN Nishina Center with a laser spectroscopy of ^{93}Nb with the interest to study the possibility to separate the ^{93m}Nb isomer from the ground state [6, 7]. These measurements yielded a total FWHM of ~ 400 MHz and hyperfine A coefficient of 1866 ± 8 MHz for the ground state and 1536 ± 7 MHz for the first excited state in a good agreement with the literature values [8].

In conclusion, the laser has been demonstrated to perform as expected and ready to be applied to in-gas-jet spectroscopy at PALIS. Furthermore, a similar laser is under construction at the University of Jyväskylä to be utilized at the IGISOL and MARA facilities.

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