Stabilization of Laser Power Using a Rubidium Clock

Qianqian Ji, Lei Han, Jingxin Sun, Yabei Su, Chenfei Wu, Xiaobo Xue and Shengkang Zhang

Science and Technology on Metrology and Calibration Laboratory,
Beijing Institute of Radio Metrology and Measurement,
Beijing, China

Email: jqq202208@163.com; xbxue203@163.com

Stable laser power is indispensable in current research, particularly in quantum precision measurement, where minor power fluctuations can significantly impact system performance. A common method for power stabilization is utilizing photodetectors to detect laser power fluctuations[1,2]. However, the inherent noise of photodetectors limits the long-term stability of laser power. To improve the long-term stability of laser power, a novel method is proposed in this paper. Based on the principle of light shift[3], this paper utilizes Rubidium atomic clocks to measure 795 nm laser power and stabilize it. This method enables the tracing of laser power fluctuations back to variations in the output frequency of atomic clocks. The experimental results indicate a significant improvement in laser power stability, decreasing from 6E-3@10000s to 1.8E-5@10000s. This research shows promise for wide application in fields such as atomic clocks, atomic gravimeters, and atomic interferometers.

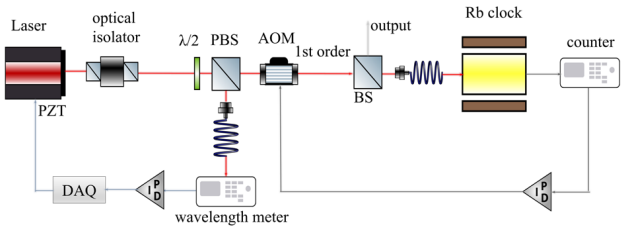

Fig. 1: Schematic diagram of the experimental setup. HWP: half wave plate, PBS: polarization splitter, BS: beam splitter.

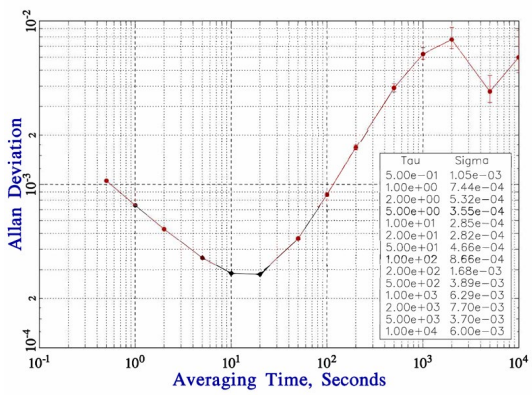

Fig. 2: The stability of laser power at free running condition.

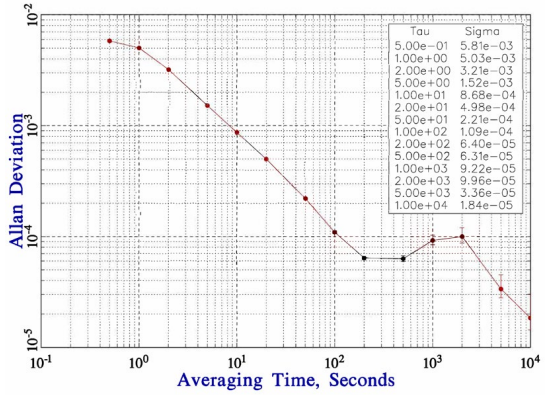

Fig. 3: The stability of laser power at locked condition.

[1] Lin, Rui, et al. "Laser power stabilization for the detection of the populations of the atomic double levels in Cs fountain clock." 2014 IEEE International Frequency Control Symposium (FCS). IEEE, 2014.

[2] Phrompao, J., et al. "Real-time and versatile laser-power stabilization with arbitrary amplitude modulation." Journal of Physics: Conference Series. Vol. 1380. No. 1. IOP Publishing, 2019.

[3] Scholtes, Theo, et al. "Light-shift suppression in a miniaturized Mx optically pumped Cs magnetometer array with enhanced resonance signal using off-resonant laser pumping." Optics Express 20.28 (2012): 29217-29222.